FASTCAM SA-Z

Hardware Manual

Revision 1.00 USEU

Photron

WARNING
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

CAUTION:
Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

- The copyright of this manual is held by PHOTRON LIMITED.
- Product specifications and manual contents can change without advanced notification.
- This manual was created taking every possible measure to ensure the accuracy of its contents. However, if you find a section which is unclear, a mistake, or an omission, please contact PHOTRON LIMITED using the contact information provided at the end of the manual.
- PHOTRON LIMITED bears no responsibility for the results of using the product or from following the instructions in this manual.

Introduction

Thank you for your purchase of Photron's high-speed camera system, the "FASTCAM SA-Z" (referred to below as the system).
This manual contains the operating instructions and warnings necessary for using the system.
Before using the system, please read the entire manual.
If any part of this manual is unclear, contact Photron using the contact information printed at the back of the manual.
After you finish reading the manual, store it in a safe place along with the warranty card and refer back to it when necessary.

Manual Notation

The following icons and symbols are used in the explanations in this manual.

Icon/Symbol	Description
	This symbol indicates content that should always be read.
	This symbol indicates instructions that should always be followed when using the software, or things to be careful of when using the software.
	This symbol indicates supplementary items to be aware of when using the system.
	This symbol indicates the location of a reference.
	This symbol indicates a space for you to make notes.
" "	This symbol is used to indicate the names of items on a screen, references, dialog names, and connectors.
[ ]	This symbol is used to indicate menu names, and sub-menu names.

Using the Manual

This section explains the layout of the manual.

- Introduction
  The introduction explains the manual and safety precautions.

- Chapter. 1 Overview
  This chapter gives an overview of the system and an explanation of its features.

- Chapter. 2 Setup
  This chapter gives an overview of the components that make up the system. It also explains basic keypad operation and a list of items that should be checked before using the system.

- Chapter. 3 Recording
  This chapter explains operations related to recording.

- Chapter. 4 Connecting a PC
  This chapter explains the procedure for connecting the system to a PC. Refer to the “Photron FASTCAM Viewer User’s Manual” for additional details on using a PC to control the system.

- Chapter. 5 Product Specifications
  This chapter explains the system’s specifications.

- Chapter. 6 Warranty
  This chapter explains about the warranty.

- Chapter. 7 Contacting Photron
  This chapter lists the contact information to use when contacting Photron if the system malfunctions or if a portion of the manual is unclear.

Using the System Safely and Correctly

In order to prevent injury to yourself and others, and to prevent damage to property, carefully observe the following safety precautions.

Photron has given its full attention to the safety of this system. However, the extent of damage and injury potentially caused by ignoring the content of the safety precautions and using the system incorrectly is explained next. Please pay careful attention to the content of the safety precautions when using the system.

Warning

This symbol indicates actions that carry the risk that a person could receive a serious injury.

Caution

This symbol indicates actions that carry the risk that a person could receive a moderate injury, or that damage to physical property might occur.

- The safety precautions to be observed are explained with the following symbols.

This symbol indicates actions that require caution.

This symbol indicates actions that are prohibited and must be avoided.

This symbol indicates actions that must always be performed.

Warning

■ Do not perform actions that will damage the AC cable or plug.
(Do not damage the cable, modify it, use it near a heater, excessively bend, twist or pull on it, place heavy objects on it, or bundle it.)
Using the cable when damaged can cause fire, electric shock, or a short circuit.

■ Do not use the system in a manner which will exceed the rating of the power outlet or wiring equipment used.
Exceeding the power rating might cause a fire from excessive heat.

■ Do not insert metallic objects inside, or pour liquids such as water on, the system.
Doing so can cause fire, electric shock, or malfunction from short circuit or heat.

■ Do not disassemble or modify the system.
There are high voltages inside the system that can cause electric shock.

■ Do not plug in or unplug the power cord with wet hands.
Doing so can cause electric shock.

■ This chapter lists the contact information to use when contacting Photron if the system malfunctions or if a portion of the manual is unclear.
Not fully plugging in the power cable can cause fire from electric shock or heat.

■ When something is wrong with the system, unplug the power cable immediately.
- When a foreign substance or liquid, such as metal or water, gets inside.
- When the outer case is broken or damaged, such as from a fall.
- When the system produces smoke, a strange smell, or strange sound.
Using the system in these conditions might cause a fire or electric shock.

■Do not use the accessories by the usage that a manufacturer does not specify. It may cause damage of protection.

Caution

■ Always unplug the system when cleaning it or when it is unused for a long period of time. Leaving or storing the system connected to the power source might cause fire from insulation deterioration or electrical discharge.

■Please consult us in advance when you perform an event by which laser light or direct rays fall on the image sensor surface.

■ Do not set the system in a location where the temperature gets unusually hot.
The trunk and inside of a car can get especially hot in summer.
Doing so can cause the outer case and internal components to deteriorate or cause a fire.

■ Do not place the system in a location prone to oily smoke or steam, or in a location with a lot of humidity or dust.
Oil, moisture, and dust conduct electricity, which can cause a fire or electric shock.

■ Ambient temperature 0-45° C, humidity 85% RH or lower, maximum altitude 2,000m or lower.
In addition, if exceeding these limits, use in a condensation-free environment.
Doing so can cause malfunction.

■ Do not store the equipment in a location where the temperature goes below -20°C or higher than 60°C. Also, prevent condensation from forming during shipment

■ When shipping, remove the connecting cable and use the original packaging or a dedicated carrying case.
Do not ship the equipment in an environment where the temperature goes below -20°C or higher than 60°C. Also, prevent condensation from forming during shipment

European Union (and EEA) only

These symbols indicate that this product is not to be disposed of with your household waste, according to the WEEE Directive (2002/96/EC), the Battery Directive (2006/66/EC) and/or your national laws implementing those Directives.

This product should be handed over to a designated collection point, e.g., on an authorized one-for-one basis when you buy a new similar product or to an authorized collection site for recycling waste electrical and electronic equipment (EEE) and batteries and accumulators. Improper handling of this type of waste could have a possible impact on the environment and human health due to potentially hazardous substances that are generally associated with EEE. Your cooperation in the correct disposal of this product will contribute to the effective usage of natural resources.

For more information about the recycling of this product, please contact your local city office, waste authority, approved scheme or your household waste disposal service or visit www.photron.com.

(EEA: Norway, Iceland and Liechtenstein)

Cleaning of the Image Sensor Surface

Electrostatic Discharge (ESD) events may cause immediate and unrecoverable damage to the image sensor. Please read the following instructions and take EXTREME CARE when cleaning the image sensor surface.

- ALWAYS take appropriate anti-static precautions when cleaning or working near the Image sensor.
- DO NOT use any form of cleaning equipment using electrostatic or ‘charged fiber’ technology.

- Please discharge any electrostatic build up in your body by touching a grounded metallic Surface before working near the camera sensor.
- Very gently, use only clean and dry air to remove dust from surface of the image sensor.
- To remove stubborn contamination use the highest grade (e.g. VLSI grade) pure Isopropyl alcohol (IPA) with optical wipes of ‘clean room’ grade.
- Extreme care must be taken! Gently wipe across the sensor in a single action. (DO NOT rub to avoid abrasive damage to delicate optical coatings on the glass surface.)

Table of Contents

Chapter. 1 Overview 1

1.1. Product Overview and Features 2

Chapter. 2 Setup 3

2.1. About the System's Components and Accessories 4
2.1.1. Components 4
2.1.2. Accessories/Options 4
2.1.3. Type 5
2.2. Part Names 6
2.2.1. Camera Body 6
2.2.2. Camera Body Part Names 7
2.2.3. Status Display LEDs on the Rear of the Camera Body 8
2.2.4. Interchangeable Lens Mounts 10
2.2.5. Remote Controller (Optional) 11
2.2.6. RS-422 Serial Control 12
2.2.7. I/O Port Connector 13
2.2.8. Power Supply Connector 15
2.2.9. SD Memory Card Slots 16
2.3. Device Connections 17
2.3.1. Connecting a Video Monitor 17
2.3.2. Connecting the AC Power Supply 18
2.3.3. Connecting the Keypad (Optional) 19
2.4. Connecting a PC 20
2.4.1. Giabit Ethernet 20

Chapter. 3 Recording 21

3.1. Image Initialization (Calibration) 22
3.1.1. Executing Calibration 22
3.1.2. Saving Calibration Settings 22
3.1.3. Loading Calibration Settings 22
3.1.4. The operation of the Mechanical shutter 23
3.2. Selecting the Frame Rate 24
3.2.1. Switching Frame Rate (20K mode Function) 24
3.3. Selecting the Resolution 25
3.4. Selecting the Shutter Speed 25
3.5. Dual Slope Shutter 28
3.6. AUTO EXPOSURE Operation 29
3.7. Image Trigger 31
3.8. Selecting the Trigger Mode 33
3.8.1. START Mode 33
3.8.2. CENTER Mode 33
3.8.3. END Mode 34
3.8.4. MANUAL Mode 34

3.8.5. RANDOM Mode 34
3.8.6. RANDOM RESET Mode 35
3.8.7. RANDOM CENTER Mode 36
3.8.8. RANDOM MANUAL Mode 37
3.9. LOW LIGHT Mode 38
3.10. VARIABLE Setting 38
3.11. White Balance Adjustment (Color Models Only) 39
3.11.1. Using Preset White Balance (Color Models Only) 39
3.11.2. Using User White Balance (Color Models Only) 39
3.12. Color Enhancement Function (Color Models Only) 40
3.13. Look-Up Table (LUT) Operations 40
3.13.1. Using a Custom LUT 43
3.14. Edge Enhancement Function 43
3.15. Partition Memory & Record 43
3.16. Simultaneous Replay/Record Function 44
3.17. Input / Output Signal Types 45
3.17.1. TRIG TTL IN Connector 45
3.17.2. TRIG TTL OUT Connector 45
3.17.3. TRIG SW IN Connector 45
3.17.4. SYNC IN Connector 45
3.17.5. GENERAL IN Connector 46
3.17.6. GENERAL OUT (1, 2, 3) Connector 46
3.18. Using External Triggers 47
3.18.1. Inputting an External Trigger Signal 47
3.18.2. Outputting External Trigger Signals 49
3.19. Using External Synchronization Signals 50
3.19.1. Inputting an External Synchronization Signal 50
3.19.2. Outputting an External Synchronization Signal 50
3.19.3. Synchronization with a variable frequency 50
3.19.4. Synchronizing Multiple FASTCAM SA-Z Systems 51
(Multiple Unit Synchronized Recording) 51
3.19.5. Synchronizing the System with Other External Devices 53
(Frame Rate Synchronized Recording) 53
3.19.6. Synchronizing the System with Other Cameras 56
(Mixed Device Synchronized Recording) 56
3.20. GENERAL Signal Settings 57
3.20.1. GENERAL IN Signal Settings 57
3.20.2. GENERAL OUT Signal Settings 58
3.21. Signal Delay 59
3.22. Event Marker Function 60
3.23. Using Programmable Switch (USER SW) 61
3.24. IRIG Time Code (External Time Synchronization) 62
3.25. IRIG-sync Operation 63
3.26. 8bit Recording Mode 64
3.27. Direct Trigger / Direct Start Mode 65

Chapter. 4 Connecting a PC 67

4.1. Connecting the Gigabit Ethernet Interface to a PC 68
4.1.1. Connecting the System and a PC 69
4.1.2. Setting the IP Address 69
4.1.3. Using DHCP (Dynamic Host Configuration Protocol) 70
4.1.4. Connecting Multiple Systems and a PC 70
4.1.5. High-speed Download Feature 70
4.1.6. Simultaneous Replay/Record Function 71
4.1.7. Gigabit Ethernet Interface Initialization 71
4.1.8. Camera IP Address Initialization 71

Chapter. 5 Product Specifications 73

5.1. Specifications 74
5.1.1. Product Specifications 74
5.1.2. General Specifications 75
5.1.3. Options 76
5.1.4. Frame Rate and Resolution 78
5.1.5. Shutter Speed List (uncertain interval extension: Disable) 82
5.1.6. Shutter Speed List (uncertain interval extension: Enable) 83
5.1.7. Shutter Speed List (special mode) 84
5.1.8. Shutter Speed List (20K mode OFF / uncertain interval extension: Disable) 86
5.1.1. Shutter Speed List (20K mode OFF / uncertain interval extension: Enable) 87
5.1.2. Recordable Image Count/Resolution (12bit) 88
5.1.3. Recordable Image Count/Resolution (8bit) 88
5.1.4. Recordable Times/Resolution (12bit) 89
5.1.5. Recordable Times/Resolution (8bit) 89
5.2. Dimensions 90
5.2.1. Camera Body 90
5.2.2. Remote Controller (Optional) 92
5.2.3. Remote Controller with LCD (Optional) 93
5.2.4. AC Power Supply Unit 94

Chapter. 6 Warranty 95

6.1. About the Warranty 96

Chapter. 7 Contacting Photron 97

7.1. Contact Information 98

Chapter. 1 **Overview**

1.1. Product Overview and Features

1.1. Product Overview and Features

The FASTCAM SA-Z is a powerful engineering tool for use in research and development, design, production, and quality control, and in numerous fields such as science, medicine, biology, aviation and space. The system features superior basic performance with mega pixel resolution, an ultra-sensitive image sensor capable of clear recording in low-light, and an ultra-high speed frame, rate of a maximum of 480,000 fps (frame per second). It also employs a hybrid design to allow operation via a monitor keypad and operation from the PC software via a gigabit Ethernet connection to more easily implement analysis of dynamic bodies that had been difficult to analyze until now.

Use the state-of-the-art technology in the FASTCAM SA-Zto slow down and observe high-speed dynamic bodies or events, and also as an input component for a dynamic image measurement system.

FASTCAM SA-Z

Chapter. 2 **Setup**

2.1. About the System's Components and Accessories

2.2. Part Names

2.3. Device Connections

2.1. About the System's Components and Accessories

2.1.1. Components

The system's standard components are listed below. Remove the components from the packaging and check them.

1.	Camera Body (with G type F mount)	One
2.	AC Power Supply Unit/AC Cable	One
3.	DC Cable	One
4.	C-mount	One
5.	Hexagonal Wrench for Changing Lens Mounts (1.5 mm, 2 mm, 4 mm, 5 mm)	One each
6.	Lens Mount Cap (built into the camera body)	One
7.	I/O (Input and Output) Cable	One
8.	FASTCAM Series Setup Disk (Driver/Application DVD)	One
9.	FASTCAM SA-Z Hardware Manual (this manual)	One
10.	Photron FASTCAM Viewer (PFV) User's Manual	One
11.	How to Make a Gigabit Ethernet Connection (Simple Procedure Manual)	One
12.	Gigabit Ethernet Interface Cable (LAN Cable)	One

2.1.2. Accessories/Options

The following options are available for the system.

1. Remote Controller for SA8/SA-X/SA-X2/SA-Z
2. Remote Controller with LCD for SA-X2/SA-Z
3. EF Remote Controll Mount Option for SA-Z
4. FASTCAM SA-Z Specialized Carrying Case
5. Photron Trigger Box
6. Mount with Filter changer(3 type)
7. Mount with Filter changer(1 type)

The accessories use only accessories meeting the specifications of the manufacturer.

2.1.3. Type

For the FASTCAM SA-Z system, there are monochrome and color versions, and for each of these versions, there are 8 GB standard memory capacity type and 16 GB (or 32GB, 64GB) high capacity type. When purchasing, it is possible to select from these models according to the application or your demands.
The Types are listed below.

Max. Frame Rate	Sensor Type	Memory	Type Name
480,000fps	Color	8GB	FASTCAM SA-Z type 480K-C-8GB
		16GB	FASTCAM SA-Z type 480K-C-16GB
		32GB	FASTCAM SA-Z type 480K-C-32GB
		64GB	FASTCAM SA-Z type 480K-C-64GB
	Monochrome	8GB	FASTCAM SA-Z type 480K-M-8GB
		16GB	FASTCAM SA-Z type 480K-M-16GB
		32GB	FASTCAM SA-Z type 480K-M-32GB
		64GB	FASTCAM SA-Z type 480K-M-64GB

Supplement

- “EF Mount model ” is prepared for each type.

2.2. Part Names

The system is composed of components including the camera body, AC power supply, and the "Photron FASTCAM Viewer" control software (referred to below as PFV).

For each of the system components.

- Do not expose to shock.
- Do not use in an area where flammable gas or dust present is present.
- Do not place in an unstable location such as on an unstable platform or an incline.
- Do not disassemble or modify.
- Do not expose to liquids such as water.
- Do not subject to excessive force.

2.2.1. Camera Body

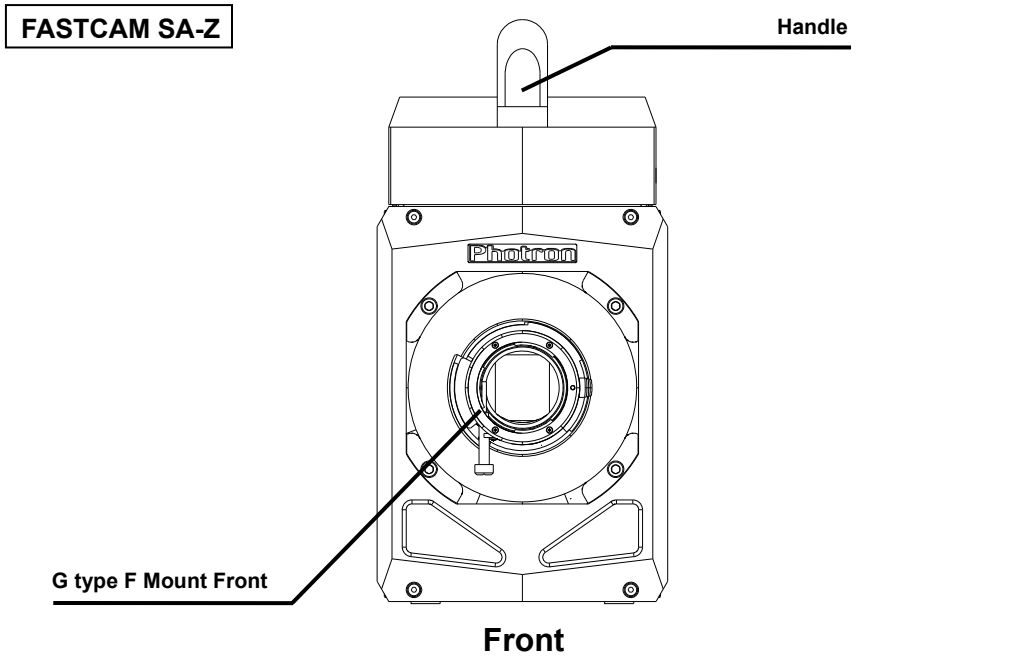
The camera body contains IC memory for image recording and has been designed to be able to record high-speed images uncompressed. The back of the camera body is equipped with the video output terminals, which can playback the recorded images on a video monitor; the Gigabit Ethernet interface, which permits full camera control and data download possible via connection to a PC; the input/output connector, which allows external synchronization signals, trigger signals, IRIG time code.

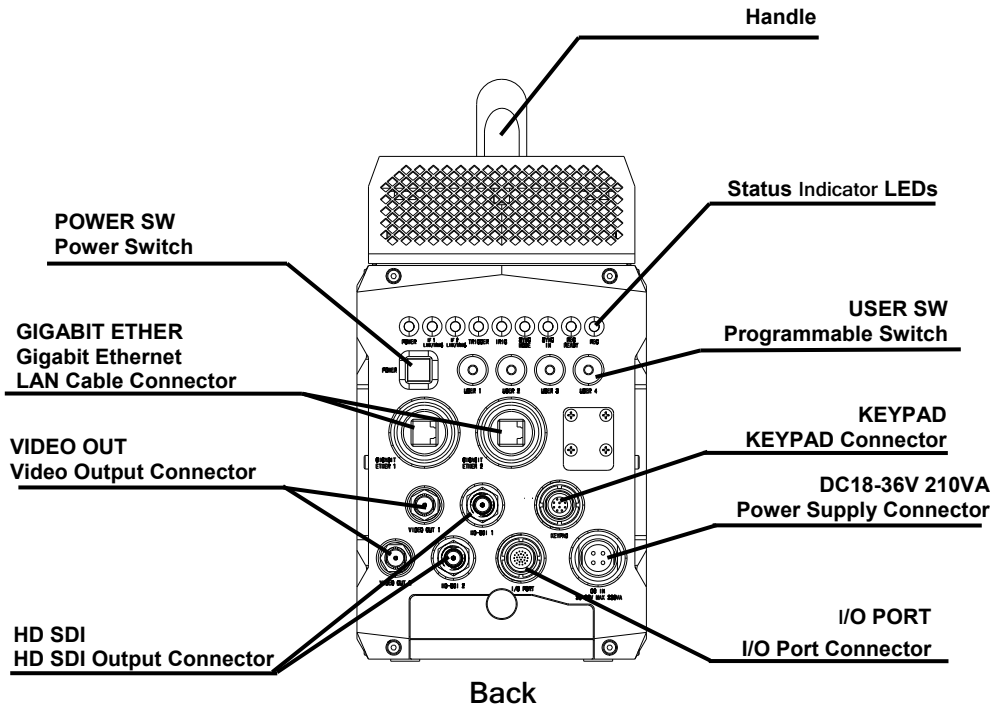
Apperance

Rear

FASTCAM SA-Z

2.2.2. Camera Body Part Names





2.2.3. Status Display LEDs on the Rear of the Camera Body

There are a number of LEDs on the rear of the system's camera body. These LEDs indicate the status of the system. The function of each LED is explained here.

- POWER (Green)
  LED ON: Power On
  LED OFF: Power Off

- IF LINK/TRANS (Red)
  LED ON: The Gigabit Ethernet interface is connected
  LED FLASHING: Data is transferring
  LED OFF: The Gigabit Ethernet interface is not connected

- TRIGGER (Yellow)
  LED ON: A trigger signal is present (being input) (The LED will illuminate for 0.1 second when the trigger signal is input.)
  LED OFF: The trigger signal is not present

- IRIG (Green)
  LED ON: The IRIG/GPS signal is present (being input)
  LED OFF: The IRIG/GPS signal is not present

- SYNC MODE (Red)
  LED ON: In external synchronization mode (synchronized to an external signal)
  LED OFF: In internal synchronization mode (synchronized to the internal signal)

- SYNC IN (Yellow)
  LED ON: A synchronization signal is present (being input)
  LED OFF: A synchronization signal is not present

- REC READY (Yellow)
  LED ON: Ready to record
  LED FLASHING: ENDLESS recording (The REC (Red) LED is also flashing)
  LED OFF: Not ready to record

- REC (Red)
  LED ON: Ready to record (The case of “ENDLESS” recording mode)
  LED FLASHING: Recording
  LED OFF: Not recording

- Illumination/blinking in operational states
  - During low light mode operationLEDs other than POWER (green) and IF LINK/TRANS (red) blink at a regular interval.
  - When calibration is run from USER SW or the remote controller LEDs other than POWER (green) and IF LINK/TRANS (red) blink alternately from right to left three times and from left to right three times.
  - During the Gigabit Ethernet interface initialization LEDs other than POWER (green) and IF LINK/TRANS (red) blink alternately from right to left and from left to right a number of times.

Reference

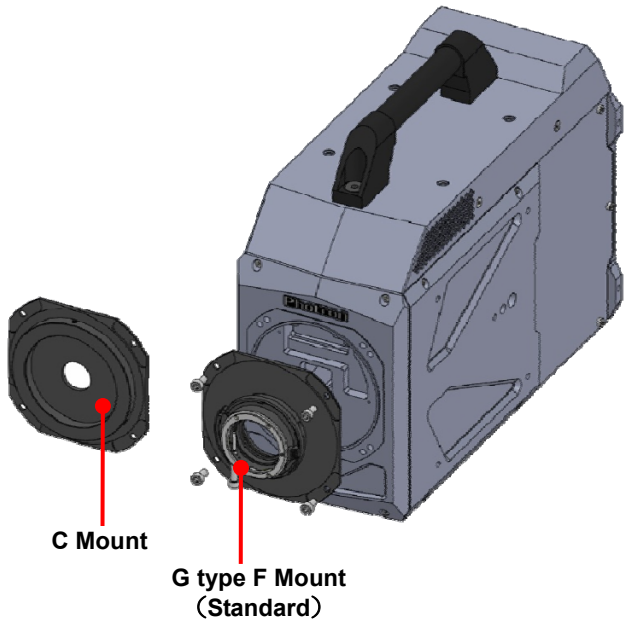
- For how to initialize the Gigabit Ethernet interface, refer to "4.1.7. Gigabit Ethernet Interface Initialization", page 71.

2.2.4. Interchangeable Lens Mounts

The lens mount on the system can be changed according to the recording purpose.
There are 3 types of interchangeable lens mounts: “G type F-mount”, “C-mount”, and “EF mount(Option)”.
The system has mechanical shutter as a standerd feature.

- How to change the lens mount (G type F-mount → C-mount)

  1. Remove the four M5 bolts with the hexagonal holes using the hexagonal wrench.
  2. Remove the G type F-mount portion as a unit.
  3. Install the C-mount unit using the bolts with hexagonal holes in the 90° diagonal holes.
  4. After installation, always verify that the unit is not loose and does not rattle.



2.2.5. Remote Controller (Optional)

The system can be operated while checking the monitor by connecting the optional remote controller to the "KEYPAD" connector on the rear of the camera body. The remote controller is also hot-pluggable; it can be plugged into and unplugged from the camera while the power is on.

Camera Body Connector	Signal	Camera Body Connector Model Name (Manufacturer)	Keypad Connector Model Name (Manufacturer)
KEYPAD	Keypad signal	ECG.2B.310.CLN (LEMO)	S22L0C-P10MJG0-820S (ODU)

Supplement

- The remote controller is optional. It is not included in the standard configuration.

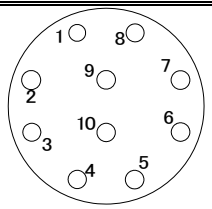
Reference

- For how to operate of the Remote Controller, refer to "Remote Controller User's Manual".

2.2.6. RS-422 Serial Control

The system supports serial control via an RS-422 connection through the "KEYPAD" connector. By setting the [STATUS OUT] menu to ON, the system status can be output via the serial connection.
For details, check the command list.
Serial control commands are available as separate list of commands. Please contact Photron or the dealer where the system was purchased regarding the command list.
A cable is also not offered as an accessory. When using RS-422 control, construct a cable using the pin diagram below for reference.

Keypad Pin Diagram



ECG.2B.310.CLN

Connector Name	Signal Name	Pin No.	Camera Body Connector Model Name (Manufacturer)	Cable Connector Model Name (Manufacturer)	Input Connector
KEYPAD	VBS	1	ECG.2B.310.CLN (LEMO)	S22L0C-P10MJG0-820S (ODU)	Not Specified
	GND	2			
	RXD+	3			
	RXD-	4			
	TXD+	5			
	TXD-	6			
	GND	7			
	TRIGGER SW	8			
	GND	9			
	+12V OUT	10			

When using the connector pins directly, refer to the chart above and ensure the wiring is correct. Incorrect wiring can cause malfunction.

The voltage on pin 10 (+12V OUT) is used to power the remote controller, do not use it for other purposes.

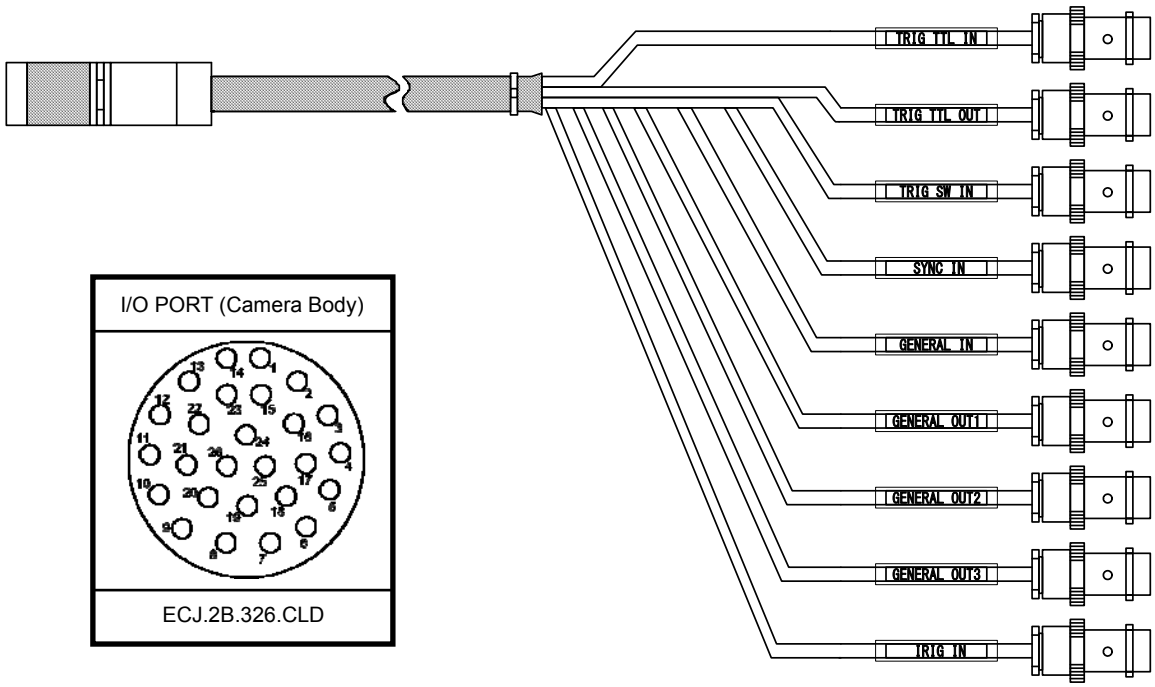
Reference

- For inquires related to our product, refer to “7.1. Contact Information”, page 98.

2.2.7. I/O Port Connector

The input/output signal connectors on the system have been bundled into a single connector, the "I/O PORT" connector, and it is possible to connect to and access each type of signal by using the specialized multi-connector. By inputting an external trigger or synchronization signal and by outputting exposure timing or synchronization signal, these signals can be used as a part of the system.

A signal other than the specified signal must not be input to the various connectors.
Use extreme caution as there is a risk of damage to both devices, the input device and the output device.



Reference

- For the signal which can be inputted, refer to “3.17. Input / Output Signal types”, page 45.

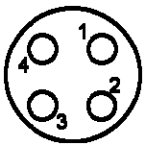
Connector Name	Signal Name	Pin No.	Camera Body Conector model No. (Manufacturer)	Cable Connector Model No. (Manufacturer)	Input Conector (Pin No.)
I/O PORT	GENERAL OUT2	1	ECJ.2B.326.CLD (LEMO)	FGJ2B326CLLD92Z (LEMO)	BNC
	GENERAL OUT3	2			BNC
	GND	3			-
	RESERVE	4			-
	RESERVE	5			-
	RESERVE	6			-
	RESERVE	7			-
	RESERVE	8			-
	IRIG GND	9			BNC
	IRIG	10			BNC
	SYNC IN	11			BNC
	TRIGGER TTL IN	12			BNC
	TRIGGER TTL OUT	13			BNC
	GENERAL OUT1	14			BNC
	GND	15			-
	GND	16			-
	RESERVE	17			-
	RESERVE	18			-
	GND	19			-
	RESERVE	20			-
	GENERAL IN	21			BNC
	TRIGGER SW	22			BNC
	-	23			-
	-	24			-
	-	25			-
	GND	26			-

Supplement

- Pin 3, 15, 16, 19, 26's GND signal is the common ground for BNC.

2.2.8. Power Supply Connector

The DC power supply input connector. Connect to the supplied AC adapter or the optional High-G Battery.
The cable connector is optionally available. When using other power supplies, construct a cable using the pin diagram below as a reference.

DC 20-36V 230VA Pin Diagram

EEJ.3B.304.CYC

Connector Name	Signal Name	Pin No.	Camera Body Connector Model Name (Manufacturer)	Cable Connector Model Name (Manufacturer)
DC20-36V 230VA	+20V - +36V IN	1	EEJ.3B.304.CYC (LEMO)	FGJ.3B.304.CYMD10Z (LEMO)
	GND	2		
	GND	3		
	+20V - +36V IN	4		

Warning When using the connector pins directly, refer to the chart above and ensure the wiring is correct.
If the wiring is incorrect, not only is there the danger of the system malfunctioning, but also of fire and electric shock.

Warning Do not use a power supply which does not meet the system's specifications, or a power supply you cannot guarantee the safety of.
By using a power supply outside of the system specifications, not only is there the danger of the system malfunctioning, but also of fire and electric shock.

Warning Please use a external power supply with the suitable rating which was estimated by IEC/EN 61010-1 3rd Edition (compiled with Cl. 6.3 and Cl. 2.5), and separated from the main circuit by double insulation or reinforced insulation

2.2.9. SD Memory Card Slots

These slots are for an SD Memory Card to save image data. Insert an SD Memory Card which is on the market.
Recorded image data can be saved on an SD card and the saved data can be played and converted to other formats by "PFV".

Reference

- Refer to “SD Memory Card User’s Manual” for the details of operation.

Supplement

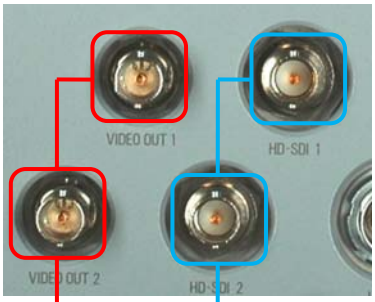
- If a SD Memory Card’s performance is not enough the required specifications, there is possibility that the writing speed will become slow and/or there will be an error. Refer to “SD Memory Card User’s Manual” for the required specifications.

2.3. Device Connections

2.3.1. Connecting a Video Monitor

Connecting video monitors to the system for checking the live image (camera pass-through image). Connect a video input connector on a video monitor to the “VIDEO OUT” connector or the “HD SDI” connector with a BNC cable according to the type of video signal to display.
Connectors that output the signals are selectable from the PFV software or the optional remote keypad.

NTSC	1080i	60Hz , 59.94Hz
	1080p	30Hz , 29.97Hz , 24Hz , 23.98Hz , 24Hz(sF) , 23.98Hz(sF)
PAL	1080i	50Hz
	1080p	25Hz , 24Hz , 23.98Hz , 24Hz(sF) , 23.98Hz(sF)



Video Monitor, etc., Video Device
VCR, etc., Video Device

HD SDI connector x2 (BNC)
The HD SDI (High Definition Serial Digital Interface) output.

VIDEO OUT connector x2 (BNC)
The composite video (NTSC/PAL) output.

Supplement

- Since the output of composite video/HD SDI is exclusive, color bars are displayed on the output not selected. (Color bars are a reference guide).
- One of the connectors can switch the output signal between Live mode and Memory mode, and the other connector will always output Live signal simultaneously.
- Use 5C-FB specification cables for HD SDI output.

2.3.2. Connecting the AC Power Supply

Connect the supplied AC power supply unit to the power supply.

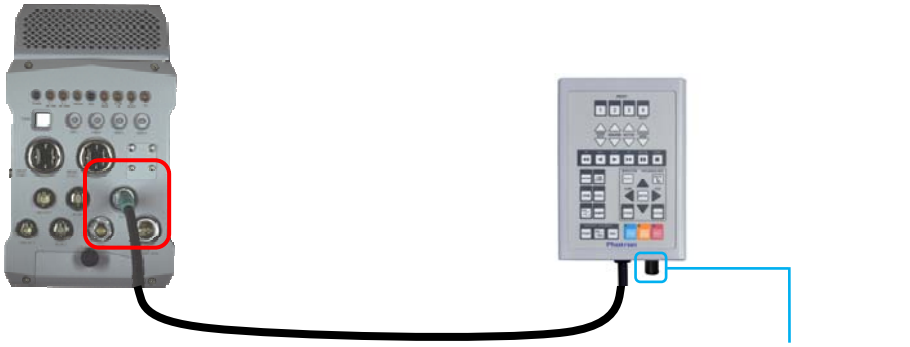
1. Confirm the Power SW is turned off.
2. Connect the AC power supply unit to the “DC20-36V 230VA” connector on the back of the camera body.
3. Connect the AC cable to the AC power supply unit.
4. Connect the AC cable to the power outlet.
5. Turn on the Power SW one the system.

Reference

- For the specification of the power supply which can be used, refer to “5.1.2. General Specifications”, page 75.

2.3.3. Connecting the Keypad (Optional)

If you have the optional Keypad, connect it by plugging the Keypad connector into the connector labeled "KEYPAD" on the rear of the camera body.



Supplement

- The Keypad is hot-pluggable. It can be plugged in and removed while the system's power is on.

Reference

- For how to operate of the Keypad, refer to "Remote Keypad User's Manual".

2.4. Connecting a PC

2.4.1. Giabit Ethernet

The system can have the operation of its functions performed from a PC using the Gigabit Ethernet interface.

This section explains the required setup when connecting the system to a PC.

To connect a PC to the system, connect the system to a commercially available 1000BASE-T-compatible interface board with a LAN cable. For the LAN cable, prepare a UTP or STP CAT5E (enhanced category 5) or higher category LAN cable. (UTP: Unshielded Twisted Pair, STP: Shielded Twisted Pair)

The maximum cable length between the PC and the system is 100 m (compliant to the 1000BASE-T specification). One PC can connect to a maximum of 64 Photron Gigabit Ethernet interface equipped cameras using a hub. When connecting multiple devices, connect through a switching hub that can connect at 1000BASE-T. The maximum length of the cable that connects the system (or PC) to the switching hub is also 100 m.

Reference

- For operating instructions of Photron FASTCAM Viewer software, refer to "Photron FASTCAM Viewer User's Manual".

Chapter. 3 **Recording**

3.1. Image Initialization (Calibration)

3.2. Selecting the Frame Rate

3.3. Selecting the Resolution

3.4. Selecting the Shutter Speed

3.5. Dual Slope Shutter

3.6. AUTO EXPOSURE Operation

3.7. Image Trigger

3.8. Selecting the Trigger Mode

3.9. LOW LIGHT Mode

3.10. VARIABLE Setting

3.11. White Balance Adjustment (Color Models Only)

3.12. Color Enhancement Function (Color Models Only)

3.13. Look-Up Table (LUT) Operations

3.14. Edge Enhancement Function

3.15. Partition Memory & Record

3.16. Simultaneous Replay/Record Function

3.17. Input / Output Signal Types

3.18. Using External Triggers

3.19. Using External Synchronization Signals

3.20. GENERAL Signal Settings

3.21. Signal Delay

3.22. Event Marker Function

3.23. Using Programmable Switch (USER SW)

3.24. IRIG Time Code (External Time Synchronization)

3.25. IRIG-sync Operation

3.26. 8bit Recording Mode

3.27. Direct Trigger / Direct Start Mode

3.1. Image Initialization (Calibration)

In order to maximize the high image quality of the system, it is necessary to correct the non-uniformity in each pixel that is inherent in the image sensor.
The system is equipped with a function to correct the output value for each pixel using the black level as a standard. Using a uniform black image as the standard, each pixel's black level is set to zero. This makes it possible to obtain faithful image output for the input light level.

Important

- In order to obtain faithful image output, execute calibration when the following settings are changed.
  - ■ When the frame rate is changed
  - ■ When the shutter speed is changed
  - ■ When the resolution is changed

  Also, depending on the settings, phenomena such as the following may occur.
  - ■ Fixed noise like horizontal bands appears
  - ■ A portion of the screen is clear, but noise appears in the area around it

  These phenomena can be resolved by executing calibration again.

3.1.1. Executing Calibration

Calibration is executed from the "Keypad (optional)" or from PFV.

Reference

- For the procedure of performing this function, refer to "Remote Keypad User's Manual" or "Photron FASTCAM Viewer User's Manual".

3.1.2. Saving Calibration Settings

.The system can save a correction data which is obtained by executing the calibration.

Supplement

- The save process might take a few minutes.

3.1.3. Loading Calibration Settings

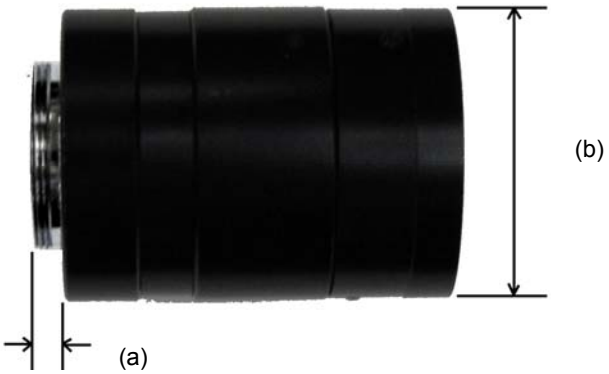
Loading and applying the image correction data which hae been saved on the system.

3.1.4. The operation of the Mechanical shutter

When using the Mechanical shutter, there is no need to shade the light since the shutter will close automatically when carrying out a calibration.

Caution

- Mechanical shutter option physically restricts available dimension of C-mount lens.
  - Projection from the lens mount flange plane (a): maximum 4 mm
  - Diameter (b) :maximum 80 mm



3.2. Selecting the Frame Rate

Images can be recorded with the system from 60 fps (50 fps with PAL) to 20,000 fps using the full 1,024x1,024 pixel resolution of the image sensor. For frame rates higher than 20,000 fps, high-speed recording is achieved by limiting the read area of the image sensor. Binning is NOT used.

Supplement

- The minimum frame rate in NTSC mode is 60 fps.
- The minimum frame rate in PAL mode is 50 fps.

3.2.1. Switching Frame Rate (20K mode Function)

This camera has two different frame rate setting modes, which can be switched from one to the other as needed. The 20K mode is set ON by default. By setting it OFF, however, the system can be operated with higher image quality.
The details of each mode are shown below:

- 20K Mode ON
  - The maximum frame rate is 480,000 fps (with image resolution of 128 x 8 pixels).
  - When full frame: 20,000 fps max.
  - The image resolution is slightly higher than that of the 20 K mode “OFF” at the same frame rate.
- 20K Mode OFF
  - The maximum frame rate is 288,800 fps (with image resolution of 128 x 8 pixels).
  - When full frame: 8,000fps max.
  - The image resolution is slightly lower than that of the 20K mode “ON” at the same frame rate.
  - .The image quality of the 20K mode “OFF” can be higher than that of the 20K mode “ON” at the same frame rate.

Reference

- The user may choose either mode depending on the frame rate and image quality required by the particular application.
  Table of frame rates and image resolutions, refer to “5.1.4. Frame Rate and Resolution”, page 78.

Important

- There may be adverse effect introduced to the image quality (such as horizontal line-like noise) when the frame rate or shutter speed is changed. To eliminate such a defect, calibration must be carried out before resuming a recording with a new setting of frame rate and/or shutter speed (refer to “3.1.1. Executing Calibration. Frame Rate and Resolution”, page 22).

3.3. Selecting the Resolution

The maximum resolution of the image sensor is 1,024 x 1,024: total 1,048,576 pixels. By reducing the resolution, images can be taken with even faster frame rates, or the recording duration can be extended accordingly.

Reference

- For more information of relation between Frame Rate and Resolution, refer to “5.1.4. Frame Rate and Resolution”, page 78.

3.4. Selecting the Shutter Speed

The shutter speed (Exposure time) is independent of the frame rate, and it is possible to control the exposure time in the frame using the electric shutter. By making an exposure that is of a shorter period than the frame rate, high-speed objects can be photographed blur-free.

The longest setting values of the shutter speed are as following:

- Frame rate is lower than 1,000 fps: 1/1,000 sec (1 msec)
- Frame rate is 1,000 fps or higher: one step shorter shutter speed setting than '1/frame' second. (Please refer to the following Supplement part for the example)

The shortest setting value of shutter speed is 1/996,932 sec (approx 1.003 usec).

When “Uncertain Interval Extension” is enabled, it is shown 1/472,992 second (about 2.11usec), and the EXPOSURE (POS / NEG) signals are output on this timing.

(Please refer to the following Important part for the details)

Supplement

- For example, when working under 500fps, the available shutter speed varies from 1/1,000 to 1/996,923 second.

  When working under 2000fps, a shutter speed varying from one faster step than 1/2,000 second, 1/2,020 second, to 1/996,923 second can be obtained.

Caution

- The numerical value of [0.xxx S] display serves as actual exposure time.
- The numerical value of [1/xxx S] display is round figure. It differs from actual exposure time a little.

Reference

- For more information of Shutter Speed, refer to “5.1.5. Shutter Speed List (uncertain interval extension: Disable.)”, page 82 and “5.1.6. Shutter Speed List (uncertain interval extension: Enable.)” page 83.

Important

- The exposure starts at the rising edge of the EXPOSE POS signal (or the falling edge of the EXPOSE NEG signal). The exact exposure end point is on the preceding of the falling edge of the EXPOSE POS signal in the range of maximum 1.11 micro seconds from the falling edge (referred to below as exposure uncertain interval). The position of the point varies according to the integral of the quantity of light input on the exposure indefinite interval. The relation between the light input and the output of the camera is non-liner during the exposure uncertain interval. The red diagonal areas on the following timing chart show the exposure uncertain intervals.
- The uncertain interval ⊿t depends on a mode setup as a following table.

Setup	uncertain intervals
20K mode is ON	Approx. 694nsec
20K mode is ON with a frame rate in the following table	Approx. 198nsec
20K mode is OFF	Approx. 1.11usec

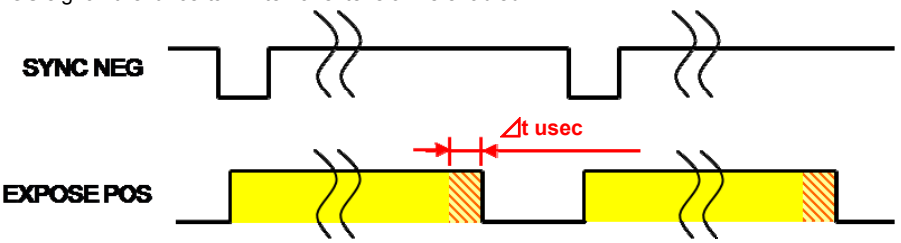
Resolution (Horizon)	Resolution (Vertical)			
	64	56	48	40
1,024	over 224,001 fps	over 240,001 fps	over 262,501 fps	over 300,001 fps
896	over 240,001 fps	over 262,501 fps	over 288,001 fps	over 315,001 fps
768	over 262,501 fps	over 288,001 fps	over 315,001 fps	over 350,001 fps
640	over 300,001 fps	over 315,001 fps	over 350,001 fps	over 360,001 fps
512	over 336,001 fps	over 360,001 fps	over 360,001 fps	over 400,001 fps
384	over 360,001 fps	over 400,001 fps	over 400,001 fps	-
256	over 400,001 fps	over 450,001 fps	-	-
128	-	-	-	-

Resolution (Horizon)	Resolution (Vertical)			
	32	24	16	8
1,024	over 336,001 fps	over 360,001 fps	over 450,001 fps	-
896	over 360,001 fps	over 400,001 fps	-	-
768	over 360,001 fps	over 450,001 fps	-	-
640	over 400,001 fps	-	-	-
512	over 450,001 fps	-	-	-
384	-	-	-	-
256	-	-	-	-
128	-	-	-	-

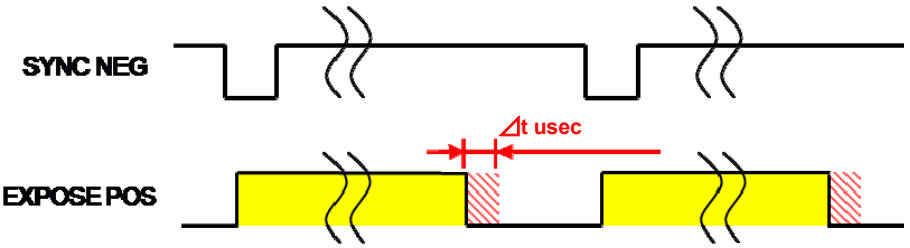
Important

- It is possible to exclude the uncertain interval with the setting. (It is excluded at the factory default setting.) The exclusion is applied to just for the shutter speed display and the EXPOSE POS/NEG signal, the exposure uncertain intervals are remains still actually.

■ EXPOSE POS signal: the 'uncertain interval extension' is enabled



■ EXPOSE POS signal the: The 'uncertain interval extension' is disabled



3.5. Dual Slope Shutter

DS SHUTTER is a mode that records the high brightness portion and low brightness portion in one image at the same time by adjusting the light exposure internally in the sensor. By using this function, when recording a subject with an extremely large difference in the brightness in the image, the sensor functions so that it can record at the proper light exposure for both the high brightness and low brightness portions.
The light exposure adjustment can be set from 0% to 99% to the subject to be recorded.

Caution

- This function cannot be used with the operations below.
  - ■ When the trigger mode is RANDOM RESET
  - ■ Auto Exposure Function
- When using the DS SHUTTER function on a color model, there are situations where the colors become unbalanced and the color reproducibility degrades.

Supplement

- The amount of adjustment is expressed as %.For the strength of the adjustment, 0% is no adjustment, 99% is the maximum effect.

3.6. AUTO EXPOSURE Operation

The system has a function that automatically varies the shutter (the sensor's exposure time) for the quantity of light input so that it will achieve the desired image output level.

After the settings are made once, in a situation where settings cannot be changed, this function displays its effect when recording in an environment where the subject's amount of light changes.

When using this function the following four items must be set in advance.
"AREA", "TARGET VALUE", "RANGE", "SHUTTER"
Each of these settings is explained below.

- AREA
  Sets the image area.
  The auto exposure function operates so that the average value of the image output level in the area specified here becomes the desired image output level.

- TARGET VALUE
  Sets the desired image output level. Set this value as a 10-bit gradation (0 to 1023).

- RANGE
  Gives the desired image output level a range. Set this value as a 10-bit gradation (0 to 1023).
  The auto exposure function operates so that the average value of the image output level in the area specified here becomes the desired image output level.

- SHUTTER
  Sets the maximum exposure time. Set in order to prevent subject blur from an exposure time that is too long.

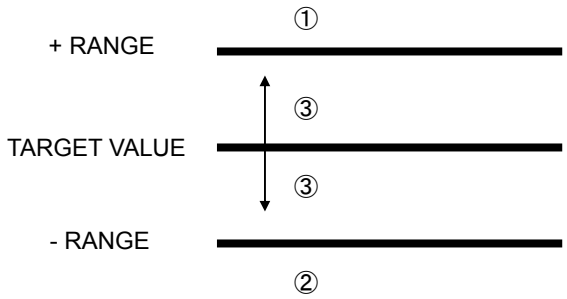
Important

- The Auto Exposure function keeps a constant image brightness by varying the shutter speed (sensor's exposure time).
  Therefore, the image may deteriorate as the shutter speed varies from the calibrated setting while using this function.
  Please refer to "3.1. Image Initialization (Calibration) ", page 22 for details.
-

Important

- When the auto exposure function is operating, the camera will not perform a shutter operation with an exposure time longer than the shutter value set here.

  These settings are shown in the diagram below.



  If the image level being output (the average value of the area set with AREA) is ①, ②, or ③, the function operates as below.

  - For position ①
    Since the image level being output is higher than the range TARGET VALUE±RANGE, the function operates to close the shutter (shorten the exposure time).

  - If position ②
    The image level being output is lower than the range **TARGET_VALUE±RANGE**, so the function operates to open the shutter (lengthen the exposure time).

  - If position ③
    The image level being output is within the range of **TARGET_VALUE±RANGE**, so the operation of the shutter is not varied.

- The DS SHUTTER function is inactive while the AUTO EXPOSURE function is being used.
- When the RANGE setting is a small value, the range of the desired image output level narrows.

- If the RANGE value is made smaller than necessary, the image level is difficult to place in the desired ③ position.
  In this case, the variable shutter operation cannot place the image level in the desired ③ position and a phenomenon occurs where the image output level is unstable.
  When a situation like this occurs, it can be resolved by making RANGE a larger value.

3.7. Image Trigger

This system has a function that automatically activates trigger when the target object area hits a predetermined image output level. This is a handy function to use when you shoot a high-speed event that does not output an effective triggering signal, or when you wish to simply automate a recording without using an external trigger signal.

The use of this function requires the following three settings to be made in advance:
AREA, REFERENCE and RANGE
Each of the above three items will be described in this section.

- AREA
  Sets a field of interest within an image to be recorded.
  The Image Trigger function activates trigger by using the averaged level of image output signal within the field of interest set here.

- REFERENCE
  Sets the reference value of the image output signal level as criterion. The value is set by the 10-bit (0 to 1023) scale.

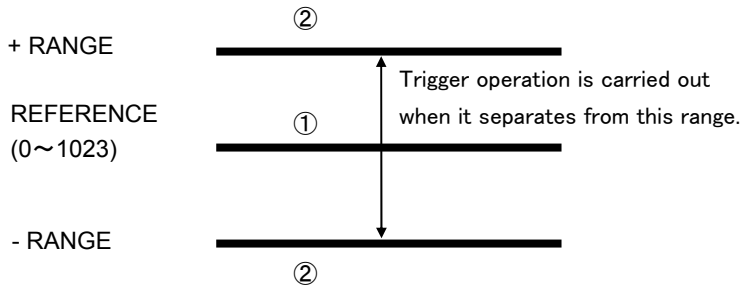
- RANGE
  Gives a range to the reference value of image output level set in the above step, REFERENCE. The value is set by the 10-bit (0 to 1023) scale.
  The Image Trigger function activates trigger if and when the average value of image output level within the field set in the AREA step goes out of the range of “REFERENCE ± RANGE” values.

Important

- The reaction speed of the Image Trigger depends on the repeating rate of video (1/23.98 to 1/60 depending on the video format).
- The Image Trigger is an auxiliary functionality that activates trigger based on the background difference within the field of view while waiting for an occurrence of a target event. There is an inevitable possibility that the system fails to trigger in the timeliest manner to capture short living events. Therefore, the use of this functionality is NOT advisable to record important experiments involving once –a -century type or very expensive events.

Important

- The Image Trigger function responds when the level of output image signal (averaged value within the field set in the above AREA step) is on the line ① or ②.



When the output image signal level (averaged value within the field set in the above AREA step) is in the position ① or ②, the system responds as follows:

- When the output level is in position ①:
  The system does not activate trigger because the level is within the predetermined range.

- When the output level is in position ②:
  The output level must first return to position ① and then the system activates the trigger at the moment the level hits or goes beyond position ②.

- If the level moves ①→②→①→②→①→②, the system responds every time the level goes from ① to ②. In this example, trigger is activated three times.

3.8. Selecting the Trigger Mode

In order to reliably capture high-speed phenomena, many kinds of trigger modes have been made available. These trigger modes are explained next.

There are eight types of trigger modes which are listed below.

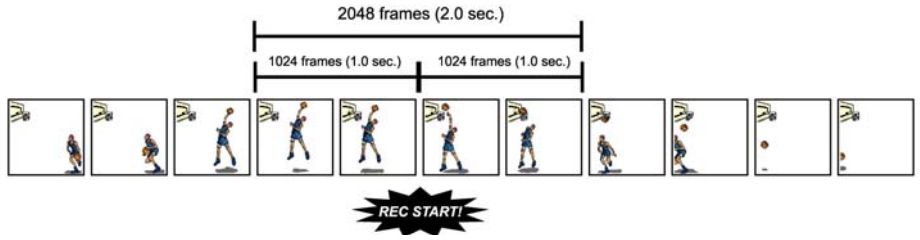
- START	- CENTER	- END	- MANUAL
- RANDOM	- RANDOM RESET	- RANDOM CENTER	- RANDOM MANUAL

3.8.1. START Mode

START mode is a trigger mode where recording starts the instant the trigger is input, the scene is recorded until the memory is full, and then recording ends. This mode is suitable for taking images of high-speed phenomena when what will happen, and when it happens, is known in advance.
For example, in a situation with a maximum useable memory of two seconds of recording, two seconds of high-speed video is saved immediately after the trigger is input.

3.8.2. CENTER Mode

CENTER mode is a trigger mode where an equal amount of content recorded before and after the trigger is input is saved to memory. This mode is suitable for viewing before and after an important instant. For example, in a situation with a maximum useable memory for two seconds of recording, one second before and one second after the trigger was input is recorded for a total of two seconds of high-speed video.



3.8.3. END Mode

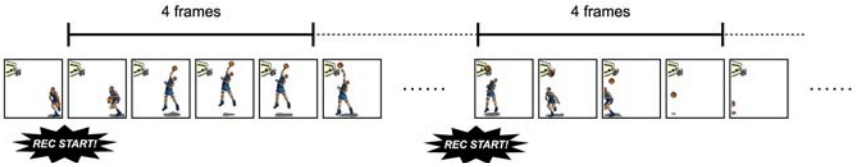
END mode is a trigger mode where the content recorded immediately before the trigger is input is saved to memory. This mode is suitable for recording a high-speed phenomenon where it is hard to predict when the important action will start and stop. For example, in a situation with a maximum useable memory for two seconds of recording, the two seconds of high-speed video immediately before when the trigger was input are saved.

3.8.4. MANUAL Mode

MANUAL mode is a trigger mode, similar to CENTER mode, where the content recorded before and after the trigger is input is saved to memory, but the proportion of time before and after the trigger can be set as required. For example, in a situation with a maximum record time of two seconds, 0.5 seconds before and 1.5 seconds after the trigger is input are recorded and saved, a total of two seconds of high-speed video.

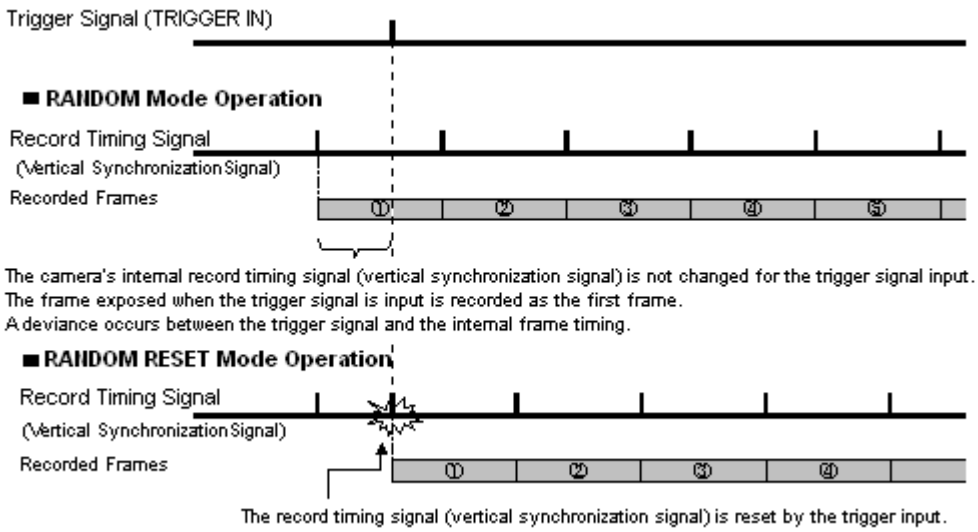
3.8.5. RANDOM Mode

RANDOM mode is a trigger mode where each time a trigger is input only a predetermined number of frames are saved to memory. For example, this function is convenient for a subject which is an irregular and repeated phenomenon which can have a trigger output produced for each cycle or occurrence. The number of frames recorded each time the trigger is input can be set as desired, in one frame increments, from one frame to the maximum of all the recordable frames available.



3.8.6. RANDOM RESET Mode

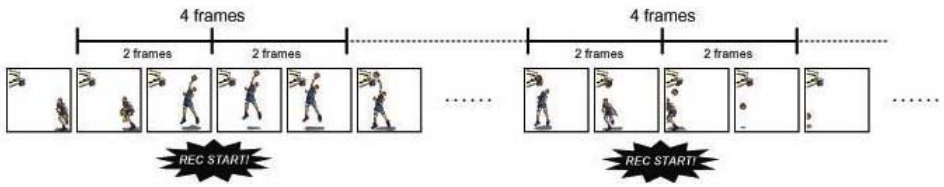
RANDOM RESET mode is explained here by comparing its operation with the normal mode. RANDOM RESET mode is a mode to improve the temporal accuracy of the record start timing and the timing of the trigger input, where, to put it simply, with the input of the trigger signal, at the timing that it is input, the camera's record timing is reset.


Trigger Signal (TRIGGER IN)
■ RANDOM Mode Operation
Record Timing Signal
(Vertical Synchronization Signal)
Recorded Frames
① ② ③ ④ ⑤
The camera's internal record timing signal (vertical synchronization signal) is not changed for the trigger signal input.
The frame exposed when the trigger signal is input is recorded as the first frame.
A deviance occurs between the trigger signal and the internal frame timing.
■ RANDOM RESET Mode Operation
Record Timing Signal
(Vertical Synchronization Signal)
Recorded Frames
① ② ③ ④
The record timing signal (vertical synchronization signal) is reset by the trigger input.

When the camera is set to the normal RANDOM mode (the same as START mode) and RANDOM RESET mode, the difference in the recording operation for the trigger input is shown graphically. In the normal RANDOM mode and START mode, the camera starts recording when the trigger is input, but the internal record timing signal is independent and it operates regardless of when the trigger is input. For this reason, there may be situations where the start time of the first frame when the trigger is input is advanced almost a full frame. The range of this overlap also cannot be known. On the other hand, in RANDOM RESET mode, the camera's internal record timing signal is reset by the trigger input and operates anew. For this reason, the trigger input time and the timing of the start of the first frame are the same. The interval from when the trigger is input until the exposure begins is approximately 1.75 us.

3.8.7. RANDOM CENTER Mode

RANDOM CENTER mode is a trigger mode, similar to RANDOM mode, where each time a trigger is input only a predetermined number of frames are saved to memory. The difference between this mode and RANDOM mode is that in RANDOM mode the number of specified frames are recorded directly after the trigger signal, whereas in RANDOM CENTER mode, at the timing of the trigger signal, the frames before and after the trigger remain in the recording memory. For example, this function is convenient for a subject which is an irregular and repeated phenomenon which can have a trigger output produced for each cycle or occurrence, and you want to check the action before and after the trigger timing. The number of frames recorded each time the trigger is input can be set as desired, in one frame increments, from one frame to the maximum of all the recordable frames available.



- Setting the RANDOM CENTER mode frame count
  Setting the frame count in RANDOM CENTER mode is the same as setting the frame count for RANDOM mode.

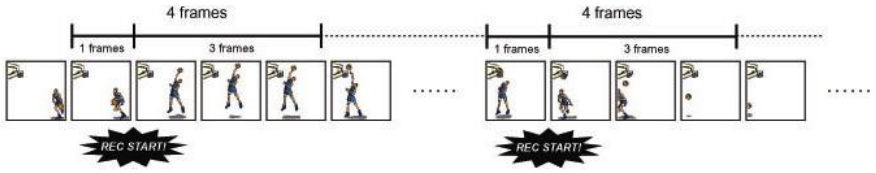
- Setting the RANDOM CENTER mode record count
  The number of trigger inputs that can be accepted in RANDOM CENTER mode is a maximum of 10. Set the number of trigger inputs in advance, and the recording operation can be ended when that amount of trigger inputs is finished.

Reference

- For how to setup of RANDOM Mode, refer to “3.8.5. RANDOM Mode”, page 34.

3.8.8. RANDOM MANUAL Mode

RANDOM MANUAL mode is a trigger mode, similar to RANDOM mode, where each time a trigger is input only a predetermined number of frames are saved to memory. The difference between this mode and RANDOM mode is that in RANDOM mode the number of specified frames are recorded directly after the trigger input, whereas in RANDOM MANUAL mode, at the timing of the trigger input, the frames before and after the trigger, each specified as desired, remain in the recording memory. For example, this function is convenient for a subject which is an irregular and repeated phenomenon which can have a trigger output produced for each cycle or occurrence, and you want to check the action before and after the trigger timing. The number of frames recorded each time the trigger is input can be set as desired, in one frame increments, from one frame to the maximum of all the recordable frames available.



- Setting the RANDOM MANUAL mode record count
  Setting the record count in RANDOM MANUAL mode is the same as setting the record count for RANDOM CENTER mode.

- Setting the RANDOM MANUAL mode frame count
  To use RANDOM MANUAL mode, the proportion of frames to record before and after the trigger must be set in advance before recording.

Reference

- For how to setup of RANDOM Mode, refer to “3.8.5. RANDOM Mode”, page 34.

3.9. LOW LIGHT Mode

The more you increase the frame rate or shutter speed of the camera, the more the amount of light entering the camera decreases, making the displayed image darker. Low light mode is a function that temporarily increases the exposure time, making the displayed image easier to see to enable you to focus and setup the camera.

The default shutter speed of this product is 1/60 second.

3.10. VARIABLE Setting

In the recording conditions settings, the frame rate and resolution can be set to the desired value following the conditions listed below.

- FRAMERATE can be set from 103 frame rates between 60 fps (50 fps for PAL) and 480,000 fps.
- The size and horizontal position of the resolution can be set in 128 (horizontal) and 8(vertical) increments.

Supplement

- The area cannot be moved to the vertical direction at the variable setting of the system.
- VARIABLE settings made in the each 20K mode ON/OFF cannot be read in the other mode, and vice versa. All settings that cannot be read are displayed gray.

3.11. White Balance Adjustment (Color Models Only)

On digital video cameras, photographing white as pure white is described as "having the appropriate white balance." On the system's color models as well, in order to take images with the correct color representation, the white balance must be adjusted for the color temperature of the light source used. The intensity of each color, R, G, and B, can be adjusted on this system. By adjusting the balance of those three colors to match the light source used, the appropriate white balance can be achieved. Two methods are available for adjusting the white balance, preset and user-editable white balance. These methods are explained in this section.

3.11.1. Using Preset White Balance (Color Models Only)

With the system, there are two types of white balance presets (5100K, 3100K) for use with common light sources. The suggested color temperature for these presets is listed below.
5100K (Daylight, Outdoors)
3100K (Halogen Light Source)

3.11.2. Using User White Balance (Color Models Only)

User white balance can be set in order to achieve the most appropriate white balance for the light source used with the system and the conditions during recording.
The values set here are stored in the camera body's internal memory as the user preset, and they can be loaded by selecting USER.
There are also two methods for setting user white balance, AUTO USER and EDIT USER.

3.12. Color Enhancement Function (Color Models Only)

Color models feature an image color enhancement setting. The image color enhancement level can be adjusted in five steps, including the OFF setting.

Menu Display	Contents
OFF	Turns the color enhancement mode off
x 0.5 (LEVEL1)	Sets x0.5 color enhancement
x 1 (LEVEL2)	Sets x1 (default) color enhancement
x 1.5 (LEVEL3)	Sets x1.5 color enhancement
x 2 (LEVEL4)	Sets x2 color enhancement

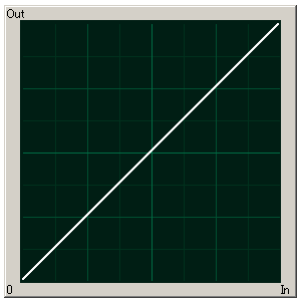
3.13. Look-Up Table (LUT) Operations

The LUT (Look-Up Table) refers to a reference table that defines the relationship between the pixel brightness gradation of the original image data taken and the brightness gradation displayed on a computer screen or video monitor.
The system contains a hardware LUT function, and you can display the image data taken with improved contrast (light and dark sharpness) or make an object in the image stand out by emphasizing a specified gray level range.
The LUT in the system and the relationship between it and video output and the PC software is explained below.

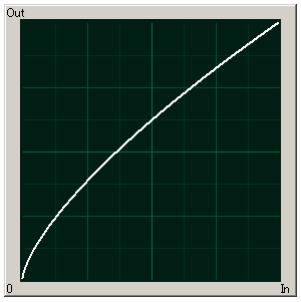
Caution

- When an image is saved with its brightness converted with the LUT, the image saved is the image that has had its brightness converted.

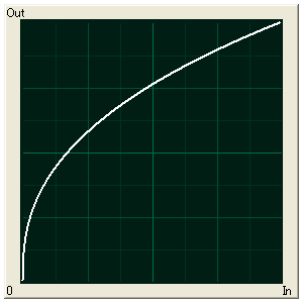
- D1: Gain 1x
  The input is always linear output. This LUT is used for normal conditions.



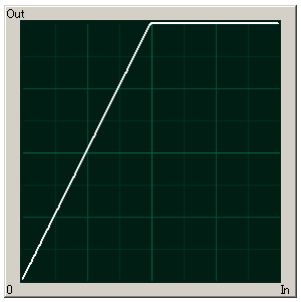
- D2: Gamma 0.6
  This LUT is 0.6.gamma correction



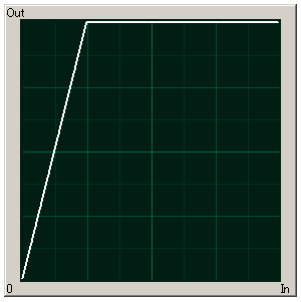
- D3: Gamma 0.45
  This LUT is 0.45 gamma correction.



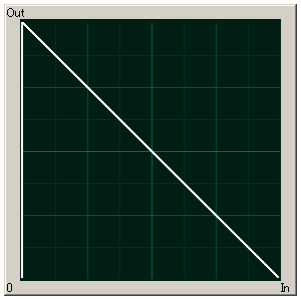
- D4: Gain 2x
  The gain is doubled and you can display the dark areas of the image emphasized.

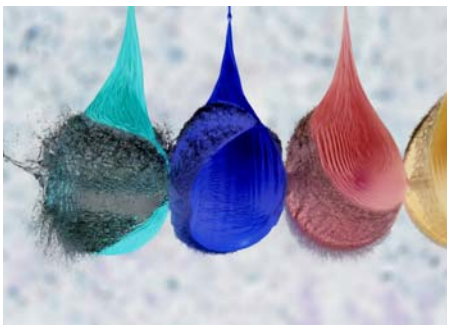


- D5: Gain 4x
  The gain is doubled and you can display the dark areas of the image emphasized. This LUT emphasizes the dark portions even more than D4.



- D6: Reverse Gradation
  The input gradation is reversed and then displayed.





3.13.1. Using a Custom LUT

Creating a LUT pattern is done with PFV.

Reference

- For the creation method of a LUT pattern, refer to “Photron FASTCAM Viewer User's Manual”.

3.14. Edge Enhancement Function

With the system's edge enhancement setting, you can enhance the edges in the recorded image in four steps, including the OFF setting.

Menu Display	Contents
OFF	Edge enhancement off.
LEVEL1	Edge enhancement set to weak.
LEVEL2	Edge enhancement set to medium.
LEVEL3	Edge enhancement set to strong.

3.15. Partition Memory & Record

The system contains internally 8 GB standard, or a maximum of 64 GB, of high-capacity memory for recording use.
This recording memory can be partitioned and assigned to each recording. Memory is partitioned into equal sizes and a maximum of 64 partitions can be set. The partitioned sections are managed by ID numbers.
Each section can be set with completely independent recording conditions, so this feature is convenient when taking consecutive recordings with changed conditions.

3.16. Simultaneous Replay/Record Function

With this system, the data recording memory may be divided into two active sections, which allows the user to record an ongoing event into one of the sections while replaying the image recorded in the other section.
Simultaneous recording and replaying reduces the waiting time for completion of a recording, while replaying the image already recorded on the other section for confirmation.

Reference

- For detailed explanation of using the function, please look into the Remote Controller Users' Manual.

Supplement

- To use the simultaneous replay/record function, two sets of video or HD SDI monitors are necessary.
  (It cannot be used with a combination of a video monitor and an HD SDI monitor)

3.17. Input / Output Signal Types

With the system, many signals can be input and output through the I/O cable. Signals that can be input and output from the I/O cable are listed below.

A signal other than the specified signal must not be input to the various connectors.

Use extreme caution as there is a risk of damage to both, the input device and the output device.

3.17.1. TRIG TTL IN Connector

The system recognizes an external TTL signal as a trigger during the READY or ENDLESS recording state. Starting and stopping recording (in the selected recording mode) is controlled with this signal.
Input voltage is 0V to +12V (H level +2.5V to +12V), positive or negative polarity, pulse width is 200 ns or greater.

3.17.2. TRIG TTL OUT Connector

A 5V TTL trigger signal is output for input to an external device.

3.17.3. TRIG SW IN Connector

This trigger is input during the READY or ENDLESS recording state by contact between the BNC connector's shield and a center pin (switch closure). The center pin normally has voltage flowing through it. Use caution to avoiding contact with other pins.

3.17.4. SYNC IN Connector

The system recognizes a TTL signal from other devices as a synchronization signal.
Input voltage is 0V to +12V (H level +2.5V to +12V), positive or negative polarity, pulse width is 200 ns or greater.

3.17.5. GENERAL IN Connector

The effect when a signal is input is described below, and can be optionally selected and set.
The input voltage is 0V to +12V (H level +2.5V to +12V), positive or negative polarity, pulse width is 200 ns or greater.

TRIG POS/NEG	Inputs a TTL trigger signal.
READY POS/NEG	Inputs a change recording ready status signal (READY ON/OFF).

Reference

- To make the setting from the menu, refer to “3.20.1. GENERAL IN Signal Settings”, page 57.
- To make the setting from PFV, refer to "Photron FASTCAM Viewer User’s Manual".

3.17.6. GENERAL OUT (1, 2, 3) Connector

These are also BNC connectors. The signals below can be changed and output from the menu or PFV.

(POS: positive polarity, NEG: negative)

SYNC POS/NEG	Outputs a vertical synchronization signal.
EXPOSE POS/NEG	Outputs the camera's exposure period signal. * Outputs during both LIVE and recording.
REC POS/NEG	Outputs a signal during recording.
TRIG POS/NEG	Outputs the trigger signal the camera received.
READY POS/NEG	Outputs a signal that indicates the recording ready state.

Reference

- For details refer to “3.20.2. GENERAL OUT Signal Settings”, page 58.

3.18. Using External Triggers

With the system, you can record by receiving various trigger signals matched to the recording application. The trigger signals that can be used on the system are explained here, along with a description of how to use them.

3.18.1. Inputting an External Trigger Signal

The external trigger signals that can be used with the system and their input system are listed below. External trigger signal input settings are also made by selecting [SYNC IN/OUT] from the menu and [TRIG TTL IN] or [GENERAL IN] from the submenu.
The signals input from the TRIG TTL IN and GENERAL IN connectors are explained in section "2.2.7. I/O Port Connector".

Connector Name (Input System)	Menu	Signal
TRIG TTL IN	TRIG POS	FET Input 0V - +12V (H level +2.5V to +12V), Positive Polarity
	TRIG NEG	FET Input 0V - +12V (H level +2.5V to +12V), Negative Polarity
GENERAL IN	TRIG POS	FET Input 0V - +12V (H level +2.5V to +12V), Positive Polarity
	TRIG NEG	FET Input 0V - +12V (H level +2.5V to +12V), Negative Polarity
TRIG SW IN	None	Contact signal

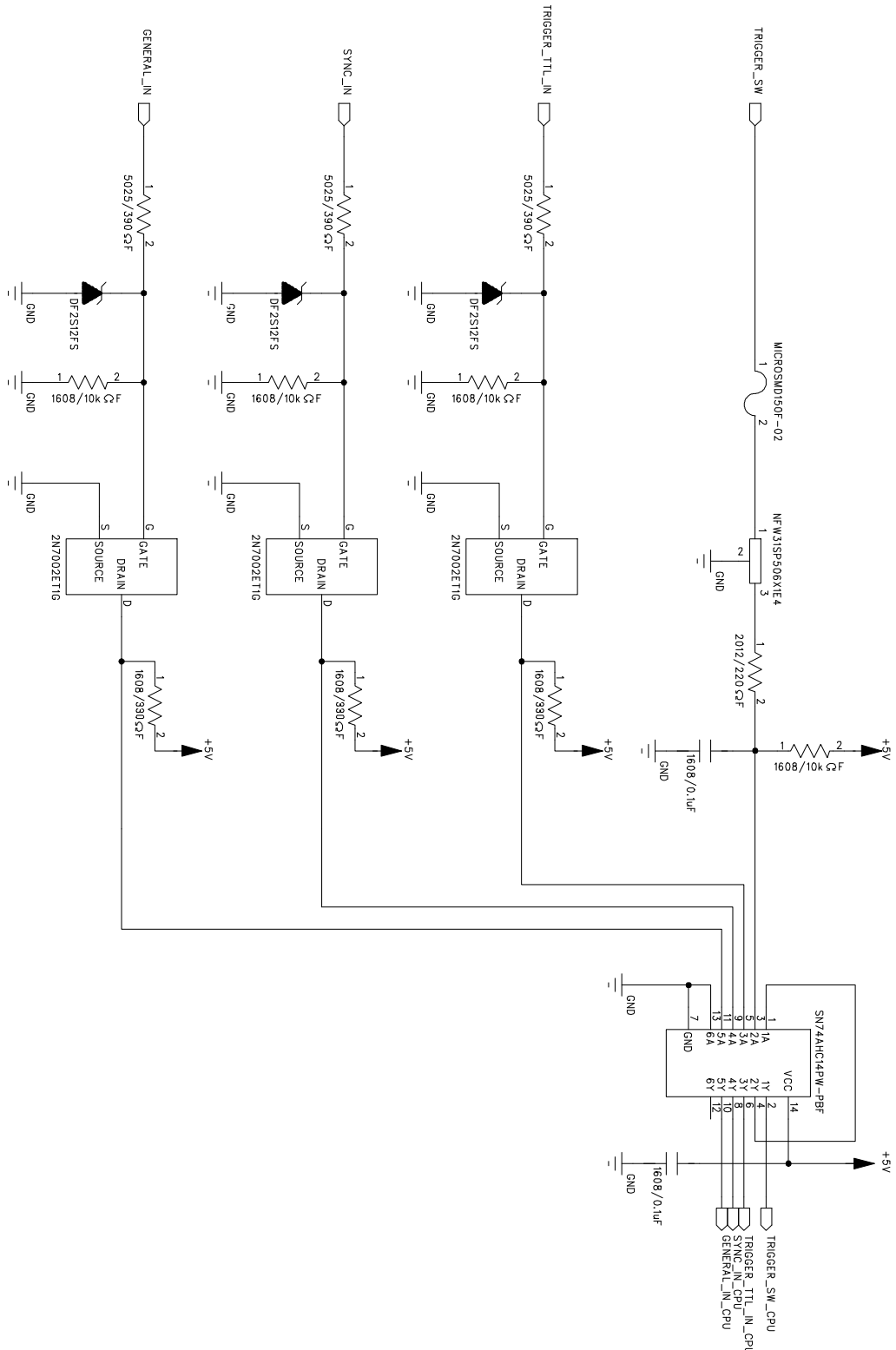
Set the signal type to be input to GENELAL IN from the menu in advance.

Use caution not to input more than specified voltage or current to the TRIG TTL IN and GENERAL IN trigger signal inputs as there is a risk of damage to the equipment.

Reference

- For the setting method of the signal inputted into GENERAL IN, refer to “3.20.1. GENERAL IN Signal Settings”, page 57.

- TRIG TTL IN , GENERAL TTL IN , TRIG SW IN , SYNC IN Circuit Diagram



3.18.2. Outputting External Trigger Signals

With the system, you can externally output trigger signals. Output is performed with the TRIG TTL OUT connector's dedicated trigger output system provided by the system, and additionally, output can also be optionally set from the GENERAL OUT connector. External trigger signal output settings are also made by selecting [SYNC IN/OUT] from the menu and [TRIG TTL] OUT or [GENERAL OUT] from the submenu.
Signal output is performed from the TRIG TTL OUT connector and the GENERAL OUT connector explained in section “2.2.7. I/O Port Connector”.

The chart below summarizes the output systems and the signals that can be output.

Connector Name (Output System)	Menu Setting	Signal Type	Delay Time
TRIG TTL OUT	TRIG POS	TTL, SW, SOFT, all TRIG pulse output CMOS (74ACT541 buffer) output, Positive Polarity.	For TRIG SW IN, approx. 14.5 usec. For TRIG TTL IN, approx. POS: 95n sec. NEG:110n sec
	TRIG NEG	TTL, SW, SOFT, all TRIG pulse output CMOS (74ACT541 buffer) output, Negative Polarity.	
	TTL IN THRU POS	TRIG TTL IN through output CMOS (74ACT541 buffer) output, Positive Polarity.	For TRIG TTL IN POS, approx. 40nsec For TRIG TTL IN NEG, approx. 53nsec
	TTL IN THRU NEG	TRIG TTL IN through output CMOS (74ACT541 buffer) output, Negative Polarity.	
GENERAL OUT	TRIG POS	TTL, SW, SOFT, all TRIG pulse output CMOS (74ACT541 buffer) output, Positive Polarity.	For TRIG SW IN, approx. 14.5usec. For TRIG TTL IN GENERAL IN, approx. POS: 95n sec. NEG: 110n sec
	TRIG NEG	TTL, SW, SOFT, all TRIG pulse output CMOS (74ACT541 buffer) output, Negative Polarity	

3.19. Using External Synchronization Signals

An external synchronization mode to synchronize to an external signal is provided on the system. By using an external synchronization signal, recording can be conducted using multiple cameras to synchronize the timing of the shots or to also synchronize the shots with external measuring devices and lighting. The procedure and precautions for using the external synchronization signal are explained below.

3.19.1. Inputting an External Synchronization Signal

An external synchronization signal can be input with the system. See the chart below for external synchronization input settings.

Menu Display	Contents	Signal (Input Signal Conditions)
OFF	Sets external synchronization off, operates independently.	(none)
ON CAM POS	Synchronizes to a positive polarity signal from Photron products.	FET Input 0V - +12V (H level +2.5V to +12V), Positive Polarity
ON CAM NEG	Synchronizes to a negative polarity signal from Photron products.	FET Input 0V - +12V (H level +2.5V to +12V), Negative Polarity
ON OTHERS POS	Synchronizes to a positive polarity signal from an external device (including other Photron products).	FET Input 0V - +12V (H level +2.5V to +12V), Positive Polarity
ON OTHERS NEG	Synchronizes to a negative polarity signal from an external device (including other Photron products).	FET Input 0V - +12V (H level +2.5V to +12V), Negative Polarity

3.19.2. Outputting an External Synchronization Signal

The system can externally output a synchronization signal. Output of the external synchronization signal is performed from the GENERAL OUT connector explained in section “2.2.7. See the chart below for external synchronization output settings.

Menu Display	Contents	Signal Type	Delay Time
SYNC POS	Outputs a positive polarity vertical synchronization signal.	CMOS (74ACT541 buffer) output, positive polarity	Approx. 315nsec
SYNC NEG	Outputs a negative polarity vertical synchronization signal.	CMOS (74ACT541 buffer) output, negative polarity	Approx. 330nsec

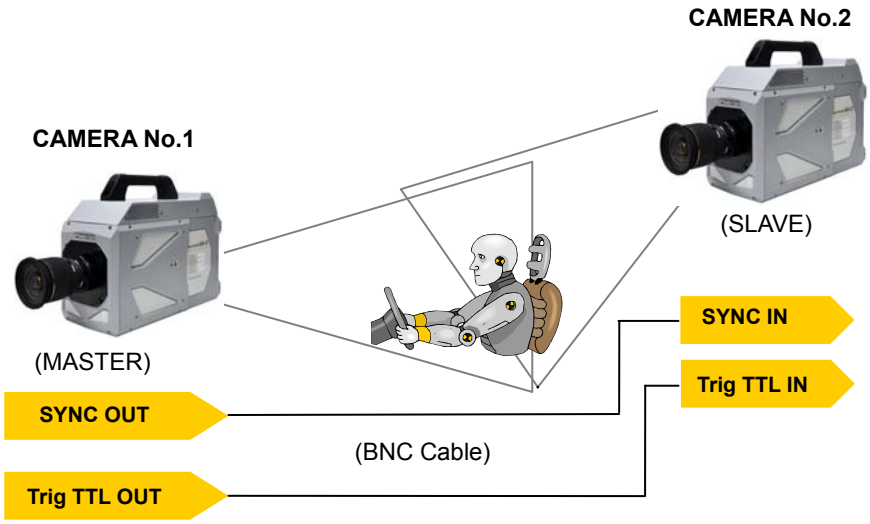
3.19.3. Synchronization with a variable frequency

When synchronizing with a varying input frequency signal, the frame rate and resolution specified before recording will be kept as a maximum value, and the camera frequency can alternate to a minimum of about 60Hz(50Hz) following to the input signal, even under the recording mode.

3.19.4. Synchronizing Multiple FASTCAM SA-Z Systems (Multiple Unit Synchronized Recording)

The system can perform synchronized recording by synchronizing multiple units using external.

- Synchronization input/output



Synchronized recording settings using the system are made with the "remote controller (optional)" or PFV. The conceptual settings when performing synchronized recording using two systems are explained here. First, decide which camera to make the master camera (outputs the synchronization signal) and the slave camera (receives the synchronization signal) from the two systems to use for synchronized recording.

- Setting the Master Camera (Outputs Synchronization)
  Set the signal output for the master camera which will output the synchronization signal. Synchronization signal settings are made with the "remote controller (optional)" or PFV.

  - For PFV (Standard)

  1. Verify that the camera mode is in LIVE mode (the image displayed is passed through from the camera). If the system is in a mode other than LIVE mode, check "Live" on the camera control panel.
  2. Select I/O on the left tree from "Camera Option" on the camera control panel.
  3. Set "GENERAL OUT1".

  - For the Remote Controller (Optional)

  1. Press the remote controller's MENU key and the menu list is displayed.
  2. Select GENERAL OUT1 from the SYNC IN/OUT submenu with the remote controller's ARROW keys and press the ENTER key.
  3. From the menu, select the signal to output from the master camera's GENERAL OUT1 connector. Move the cursor to the SYNC POS item with the ARROW keys and press the

ENTER key to select.

4. The master camera is set to output a positive polarity vertical synchronization signal from its GENERAL OUT1 connector.

- Setting the Slave Camera (Receives the Synchronization Signal)

  Next, set the synchronization signal input for the slave camera which will receive the synchronization signal supplied by the master camera. Synchronization signal settings are made with the "remote controller (optional)" or PFV.

  ■ For PFV (Standard)

  1. Verify that the camera mode is in LIVE mode (the image displayed is passed through from the camera). If the system is in a mode other than LIVE mode, check "Live" on the camera control panel.
  2. Select I/O on the left tree from "Camera Option" on the camera control panel.
  3. Set SYNC IN to "ON CAM POS".

  ■ For the Remote Controller (Optional)

  1. Input the slave camera's synchronization. Connect the slave camera's SYNC IN connector with the master camera's GENERAL OUT1 connector using a BNC cable. When the synchronization signal is input to the SYNC IN connector, the SYNC IN LED (yellow) on the rear of the slave camera illuminates.
  2. Set the synchronization signal type that slave camera will receive. Press the remote controller's MENU key and the menu list is displayed.
  3. Select SYNC IN from the SYNC IN/OUT submenu with the remote controller's ARROW keys and press the ENTER key.
  4. The output previously set on the master camera has positive polarity (POSITIVE), therefore it is necessary to make the setting on the slave camera controller the same, positive polarity (POSITIVE). Move the cursor to the ON CAM POS item with the ARROW keys and press the ENTER key to select.

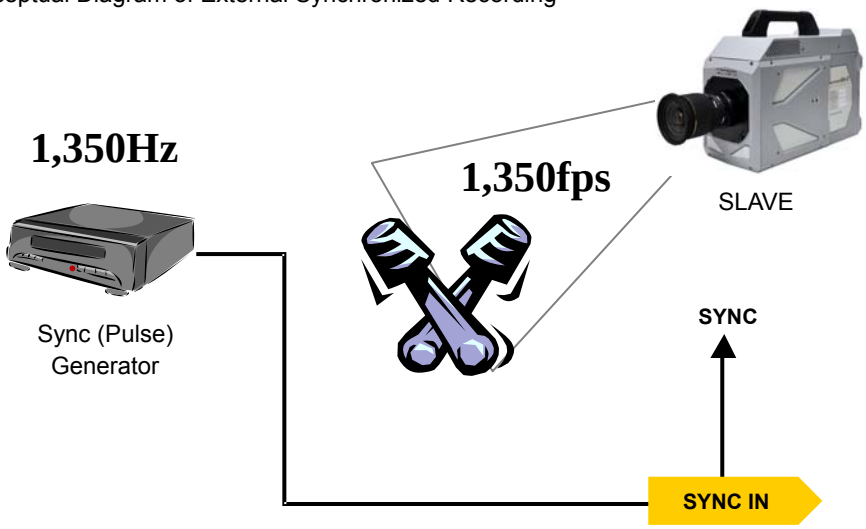
Important

- If steps, 2 to 3 are completed when no synchronization signal is being input, the camera will not operate normally. As detailed in the procedure, make the settings when the signal is being input.
- It is necessary to connect a "Trigger signal" separate from a "Synchronized signal".
- Please connect a "Trig TTL OUT" on a master camera and "Trig TTL IN" on any slave cameras,if you need to operate multiple camera system with a Trigger signal on a master camera.

3.19.5. Synchronizing the System with Other External Devices (Frame Rate Synchronized Recording)

With the system, in addition to the frame rate preset in the system, a function has been provided where you can receive a synchronization signal externally, set the frame rate with that frequency, and record.
In this way, for example, the system can be synchronized with a dynamic body that spins at 1,350 revolutions a second to conduct high-speed recording at 1,350 fps. This can open up broad applications that were unavailable until now.

- Conceptual Diagram of External Synchronized Recording



This function using an external synchronization signal to synchronize the camera to the desired frame rate is explained here.

Important

- When conducting frame rate synchronization recording with the system, the input signal must meet the following conditions.
  - ■ FET Input 0V - +12V (H level +2.5V to +12V), positive polarity or negative polarity
  - ■ 60 Hz (50 Hz for PAL) to 480,000 Hz

- System Settings

  Frame rate synchronization signal settings on the system are made with the "remote controller (optional)" or PFV.

  ■ For PFV (Standard)

  1. Verify that the camera mode is in LIVE mode (the image displayed is passed through from the camera). If the system is in a mode other than LIVE mode, check "Live" on the camera control panel.
  2. Select I/O on the left tree from "Camera Option" on the camera control panel.
  3. Set SYNC IN to "ON OTHERS POS/NEG".

  ■ For the Remote Controller (Optional)

  1. Input the synchronization signal from the device that generates the signal to the system. Connect the synchronizing device's output signal to the system's SYNC IN connector using a BNC cable.
  2. When the synchronization signal is input to the SYNC IN connector, the SYNC IN LED (yellow) on the rear of the system illuminates. (* If the synchronization signal is lost, the LED goes out.)
  3. Press the remote controller's MENU key and the menu list is displayed.
  4. Select SYNC IN from the SYNC IN/OUT submenu with the remote controller's ARROW keys and press the ENTER key.
  5. Use the remote controller's ARROW keys to select the input signal. Select ON OTHERS POS (positive polarity) or ON OTHERS NEG (negative polarity) according to the polarity of the external synchronization signal.
  6. When the setting is complete, press the ENTER key to finish.
  7. Output the signal from the synchronization device and verify that the system recognizes the output frequency and synchronizes its frame rate. The recognized frame rate will display in the lower left of the video monitor.

Caution

- If no synchronization signal is input or the input signal is under 60Hz (50Hz) during steps 3 to 7, or the synchronization signal is lost, the display shows "NO SYNC INPUT".
  If steps 3 through 7 are done inputting a signal over 480,000 Hz , the display shows “OVER SYNC INPUT”.
  In either case, you cannot record normally.
- A minute error occurs in the input synchronization signal due to the construction of the internal circuitry of this function.
  An error of ±10 ns occurs for the input synchronization signal in the actual operation.
  Since the frame rate display value on the monitor is in 1Hz units, the error may be shown larger than the actual operation (an error of about ±1-5Hz is produced).
  For example, when performing external device synchronization inputting a synchronization signal of 10000Hz, the monitor display error is:
  10,000 Hz ±1Hz = 9,999 fps to 10,001 fps.

3.19.6. Synchronizing the System with Other Cameras (Mixed Device Synchronized Recording)

Using the function (frame rate synchronization recording) in the previous section, "3.19.5. Synchronizing the System with Other External Devices (Frame Rate Synchronized Recording)", mixed-type synchronized recording can be performed with Photron's other high-speed cameras (except for some older products).
In particular, the FASTCAM SA series, FASTCAM APX-RS and FASTCAM MC2, FASTCAM MC2.1, FASTCAM MH4-10K are compatible with collective control by the PFV control software.

- Basic Process

1. Decide the master camera (the source of the synchronization signal) and the slave camera (the camera that will operate according to the synchronization signal from the master). Basically, by making the master camera the camera with the lowest maximum frame rate that can be set, you can avoid setting a synchronization signal speed the slave camera cannot receive.
2. Connect the master camera's Sync output connector to the slave camera's V-SYNC input connector with a BNC cable, select the synchronization signal output polarity on the master camera, and then set the slave camera to be operated by that signal.

Reference

- For camera models that can perform synchronized recording or for detailed instructions on making the settings, contact Photron at the contact information in "7.1. Contact Information".

3.20. GENERAL Signal Settings

3.20.1. GENERAL IN Signal Settings

Details of the signals output from the GENERAL OUT connector explained in section “3.17. Contact Information” are shown in the chart below.

Menu Display	Contents	Signal (Input Signal Conditions)
TRIG POS	Inputs a positive polarity trigger signal.	FET Input 0V - +12V (H level +2.5V to +12V), Positive Polarity
TRIG NEG	Inputs a negative polarity trigger signal.	FET Input 0V - +12V (H level +2.5V to +12V), Negative Polarity
READY POS	Inputs a positive polarity READY signal. READY ON/OFF is switched by a pulse input.	FET Input 0V - +12V (H level +2.5V to +12V), Positive Polarity
		FET Input 0V - +12V (H level +2.5V to +12V, Negative Polarity
READY NEG	Inputs a negative polarity READY signal. READY ON/OFF is switched by a pulse input.	FET Input 0V - +12V (H level +2.5V to +12V), Positive Polarity
		FET Input 0V - +12V (H level +2.5V to +12V), Negative Polarity

When using the camera as a part of a system, verify the characteristics of the input signals before using them.

3.20.2. GENERAL OUT Signal Settings

Details of the signals output from the GENERAL OUT connector explained in section “3.17. Contact Information” are shown in the chart below. There are three GENERAL OUT connectors and individual settings can be made for each connector.

Menu Display	Contents	Signal Type
SYNC POS	Outputs a positive polarity vertical synchronization signal.	+5V CMOS output, Positive Polarity
SYNC NEG	Outputs a negative polarity vertical synchronization signal.	+5V CMOS output, Negative Polarity
EXPOSE POS	Outputs the sensor's exposure interval at H level.	+5V CMOS output, Positive Polarity
EXPOSE NEG	Outputs the sensor's exposure interval at L level.	+5V CMOS output, Negative Polarity
REC POS	Outputs an interval signal during recording at H level.	+5V CMOS output, Positive Polarity
REC NEG	Outputs an interval signal during recording at L level.	+5V CMOS output Negative Polarity
TRIG POS	Outputs the trigger signal received by the camera at H level.	+5V CMOS output, Positive Polarity
TRIG NEG	Outputs the trigger signal received by the camera at L level.	+5V CMOS output, Negative Polarity
READY POS	Outputs a signal at H level during the trigger wait state. (READY in START mode.) Only valid during START, CENTER, END, and MANUAL modes.	+5V CMOS output, Positive Polarity
READY NEG	Outputs a signal at L level during the trigger wait state. (ENDLESS recording state in CENTER, END, MANUAL) Only valid during START, CENTER, END, and MANUAL modes.	+5V CMOS output, Negative Polarity
IRIG RESET POS	Outputs the camera's internal IRIG reset signal (1PPS) at H level.	+5V CMOS output, Positive Polarity
IRIG RESET NEG	Outputs the camera's internal IRIG reset signal (1PPS) at H level.	+5V CMOS output, Negative Polarity

When using as a part of a system, verify the characteristics of the output signals before using them.

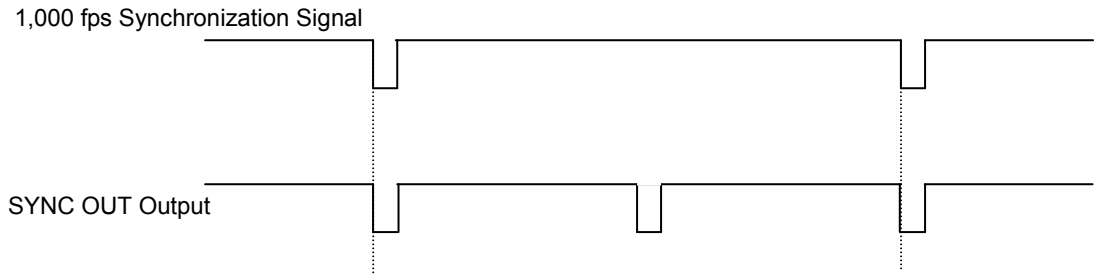
3.21. Signal Delay

With the system, you can set the signal delay time or pulse width for the various signals that are input and output. Pulse width and delay settings for the various signals to input/output are made with PFV or the remote controller (optional). The content of each setting is listed in the chart below.

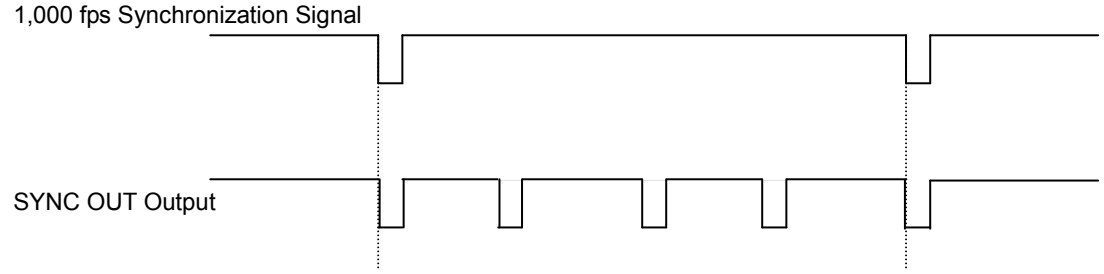
Setting Item	Setting Range (Value)
TRIG TTL IN DELAY	0-60 (s) 100 ns units
SYNC IN DELAY	0-1/frame rate (s) 100 ns units
GENERAL IN DELAY	0-60 (s) 100 ns units
TRIG OUT WIDTH	0-1 (ms) 100 ns units
SYNC OUT DELAY	0-1/frame rate (s) 100 ns units
SYNC OUT WIDTH	0-500 (us), 1/frame rate (s) at 2,000 fps or higher 100 ns units
EXPOSE OUT DELAY	0-1/frame rate (s) 100 ns units
SYNC OUT TIMES	0.5, 1, 2, 4, 6, 8, 10, 20, 30 (* x1 is standard output)

- SYNC OUT TIMES
  Values 1, 2, 4, 6, 8, 10. A value of 1 is normal output.
  Set from the SYNC IN/OUT menu, SYNC OUT TIMES submenu.
  Output a SYNC (vertical synchronization signal) from SYNC OUT that is 30 times SYNC.

  Example: For a frame rate of 1,000 fps, SYNC OUT TIMES setting of 2.



Example: For a frame rate of 1,000 fps, SYNC OUT TIMES setting of 4.



Caution

- An accurate frequency is output, but when SYNC OUT TIMES is set to a large value with a high frame rate, the setting may result in frequency errors.

Caution

- There are following limitations in SYNC OUT TIMES function

Frame Rate			Restriction
	~	60,000fps	No Limit
60,001fps	~	90,000fps	x30 is unavailable
90,001fps	~	480,000fps	x20 and x30 are unavailable

3.22. Event Marker Function

With the system, it is possible to input an external signal during recording, at the instant the frame number is stored, and during playback you can immediately access, or jump to, the stored frame numbers (event markers). This a separate feature from the trigger point, by marking interesting points during recording, these points can be easily called up for review during playback. The event marker can store ten positions within a sequence.

The frame number recording occurs on the pulse's edge, and the next frame after the pulse's edge is input is stored as the event marker. Event marker settings can be made with the "Remote controller (optional)" or PFV.

3.23. Using Programmable Switch (USER SW)

There are four switches that can be set on the back of the system. Settings for the switches are made from the menu and they can each be assigned a different function. The content of each setting is listed in the chart below.
As an example, setting the USER1 switch on the back of the camera body is explained here.

- PFV

Setting	Explanation
OFF	Does not assign a function.
Change Frame Rate	Raises the frame rate
Change Resolution	Lowers the resolution
Change Shutter Speed	Increases the shutter speed.
Change Trigger Mode	Changes the trigger mode.
Fitting image	Adjusts the size of the image displayed on the video output to be the maximum for the current resolution.
Status Display	Displays the status of camera settings on the video output.
Switch LIVE/MEMORY	Switches between LIVE and MEMORY states.
Record Ready	Sets the record ready state.
Record	Starts recording.
Low-Light	Turns low-light mode ON/OFF.
Shading	Performs black level calibration. Press this button once and the LEDs on the back of the camera illuminate back and forth from left to right and from right to left to inform you of the ready state. Afterwards, with the sensor shielded, press the button once more to complete calibration.

- Remote Controller (Optional)

Setting	Explanation
OFF	Does not assign a function.
FRAMERATE SEL	Raises the frame rate.
RESOLUTION SEL	Lowers the resolution
SHUTTER SEL	Increases the shutter speed.
TRIGGER SEL	Changes the trigger mode
FIT	The same function as the [FIT] key on the keypad.
STATUS	The same function as the [STATUS] key on the keypad.
LIVE	The same function as the [LIVE] key on the keypad.
REC READY	The same function as the [REC READY] key on the keypad.
REC	The same function as the [REC] key on the keypad.
LOW LIGHT	The same function as the [LOW LIGHT] key on the keypad.
CALIBRATE	The same function as the [CALIBRATE] key on the keypad.

3.24. IRIG Time Code (External Time Synchronization)

The system supports IRIG-B input and can add an IRIG code to each recorded frame. The sample timing for the IRIG code is once each frame.
The recorded IRIG code is displayed on the VIDEO display or with the “Photron FASTCAM VIEWER” software.

- IRIG Code Input Specification

Connector	BNC
Code Format	IRIG-B (122) Analog
Amplitude	1.0Vp-p min,8.0Vp-p max
Modulation Ratio	3:1 to 6:1

Supplement

- IRIG Time Code is used when synchronizing a camera with external equipment in time.
  It is a convenient function when apparatus is physically separated.
- When the IRIG code is being input, the IRIG code is displayed in white, and is displayed to the left.
- The IRIG offset time is also displayed below it. When the IRIG code is not being input, the IRIG code is displayed in grey. At that time, the counter is the camera’s internal counter and it continues to count.

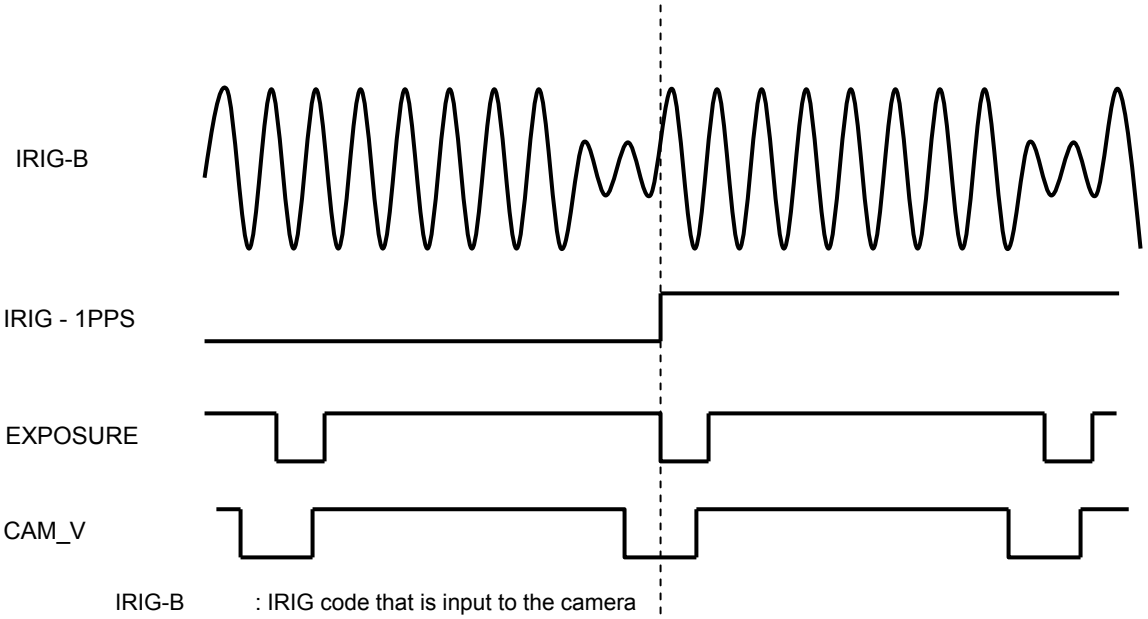
Caution

- **Limitation of use of IRIG code**
  With the Image Trigger function, IRIG code cannot be used when the specified number of frames is 32 or fewer in RANDOM CENTER or RANDOM MANUAL trigger mode.

3.25. IRIG-sync Operation

This camera system supports IRIG-sync operation, in which the sensor drive signal is synchronized with the input of IRIG-B signal.

- How IRIG-sync operation works?
  In IRIG-sync operation, the image sensor is driven by the timing signal shown below. Exposure to the sensor ends at the start of the IRIG-1PPS signal



IRIG-B : IRIG code that is input to the camera
IEIG-1PPS : 1PPS timing of the IRIG code
EXPOSURE : Exposure to the camera sensor (exposure is indicated by high duration)
CAM_V : Camera's vertical sync signal

Reference

- For the settig about the function, refer to the "Photron FASTCAM Viewer User's Manual" or the "Remote Controller User's Manual".

3.26. 8bit Recording Mode

Since the image sensor of 12 bits specification is being used for this product, it is usually recorded at 12 bits. By using 8 bits Recording Mode Mode, it is possible to record by 8 bits.

When data is recorded in the 8-bit mode, the amount of data is smaller than in 12-bit mode. Therefore, it is possible to record for a longer amount of time.

8bit Recording Mode setting can be made with the “Remote controller (optional)" or PFV.

Reference

- For the details of a 8 bit Recording Mode setup, refer to「5.1.8. Recordable Image Count/ Resolution(Bit depth)」,Page 88

3.27. Direct Trigger / Direct Start Mode

The system recording operation responding to an input trigger signal can be configured according to varies of customer's needs.

- DIRECT TRIGGER Mode (This mode is NOT supported on PFV software)
  - START TRIGGER Mode
    Recording starts immediately upon the second trigger input.
  - CENTER, END, MANUAL TRIGGER Mode
    Once the trigger signal is input, the camera will be shifted to endless recording state.
- DIRECT START Mode
  - START TRIGGER Mode
    The same operation as when the direct trigger mode is off.
  - CENTER, END, and MANUAL TRIGGER Modes
    Once the trigger signal is input, the camera is shifted to endless recording state. In this circumstance, either the "RECORD" button of PFV software or the GENERAL IN Connector under ReadyPos state, furthermore the "RECORD" button of LCD Remote Controller can trigger a record signal to the camera.

Reference

- For details of how to set the camera to DIRECT START Mode, refer to "Remote Controller User's Manual" or "Photron FASTCAM Viewer User's Manual".
- For details of GENERL IN signal settings, refer to "3.20.1. GENERAL IN Signal Settings".

Caution

- In case of using Direct Trigger, existing memory date is overwritten immediately when a trigger is input.

MEMO

Chapter. 4 **Connecting a PC**

4.1. Connecting the Gigabit Ethernet Interface to a PC

4.1. Connecting the Gigabit Ethernet Interface to a PC

The system can have the operation of its functions performed from a PC using the Gigabit Ethernet interface.This section explains the required setup when connecting the system to a PC.

To connect a PC to the system, connect the system to a commercially available 1000BASE-T-compatible interface board with a LAN cable. For the LAN cable, prepare a UTP or STP Cat 5e (enhanced category 5) or higher LAN cable. (UTP: Unshielded Twisted Pair, STP: Shielded Twisted Pair)
The maximum cable length between the PC and the system is 100 m (compliant to the 1000BASE-T specification).. One PC can connect to a maximum of 64 Photron Gigabit Ethernet interface equipped cameras using a hub. When connecting multiple devices, connect through a switching hub that can connect at 1000BASE-T. The maximum length of the cable that connects the system (or PC) to the switching hub is also 100 m.

The system has two sets of Gigabit Ethernet interface connectors incorporated. Using these two connectors simultaneously will make much faster download of image data possible.

Reference

- For the setting method of IP address for camera system, refer to “4.1.2. Setting the IP Address”, page 69.
- For the setting method of control PC, refer to “Photron FASTCAM Viewer User's Manual”.
- Please refer to the [GigabitEthernet Interface Connection Tutorial Manual」for detail instruction on PC connection setting.
- About the high-speed download feature using two cables, please see the explanation in “4.1.5 High-speed Download Feature” given in page 71.

Supplement

- Photron recommends using an STP cable over long distances or in noisy locations.

Important

- The system is only 1000BASE-T compatible. When using a PC compatible with only 10BASE-T or 100BASE-TX, the PC must be connected through a 10BASE-T, 100BASE-TX, and 1000BASE-T compatible switching hub.
- The system's factory default IP address is below:

IP ADDRESS > GIGABIT ETHER1 192.168.0.10
GIGABIT ETHER2 192.168.1.10
NETMASK > GIGABIT ETHER 1 255.255.255.0
GIGABIT ETHER 2 255.255.255.0
GATEWAY ADDRESS > 0.0.0.0
PORT > 2000 (Fixed, not changeable)

4.1.1. Connecting the System and a PC

Connect the LAN cable to the system as shown below.

Insert the LAN cable into the "GIGABIT ETHER1" or “GIGABIT ETHER2” connector.

Caution

- It is NOT supported to connect and operate one camera synchronously using two PCs via the “GIGABIT ETHER1” connector and ”GIGABIT ETHER2” connector respectively.

4.1.2. Setting the IP Address

The IP address can be specified using a remote controller (option) or using the PFV software.

Caution

- When connecting the system to a PC or when connecting other Gigabit Ethernet interface compatible Photron cameras, set each of those devices to a different IP address. Also, when connecting the system to an existing network, do not use IP addresses that are already in use on the network.

Reference

- For the procedure for setting the IP address of the system, refer to the "Photron FASTCAM Viewer User's Manual" or the "Remote Controller User's Manual".

4.1.3. Using DHCP (Dynamic Host Configuration Protocol)

The system is compatible with DHCP. In an environment where DHCP is used, the system's IP address can be acquired from the DHCP server.

Reference

- For details, refer to the "Photron FASTCAM Viewer User's Manual".

4.1.4. Connecting Multiple Systems and a PC

With PFV, the system’s control software, one PC can connect to and control multiple FASTCAM series camera systems.

Caution

- When connecting to multiple systems, set the IP address of each one to a unique setting.

4.1.5. High-speed Download Feature

The system has two sets of Gigabit Ethernet interface connectors incorporated. Using these two connectors simultaneously will make much faster download of image data possible.

1. Conduct settings for connecting both Gigabit Ethernet 1 and Gigabit Ethernet 2 on the PC being used.
2. On the PFV, make connection settings for one of the two connectors.
3. Connect between the PC and both connectors with LAN cables.
4. The PFV recognizes the two connectors as one single camera.
   Download is made through the two LAN cables in high-speed download setting.

Reference

- For connection to the PC, please refer to the explanation given in “GigabitEthernet Interface Connection Manual”

Caution

- When connecting, please be careful not to duplicate the IP address of Gigabit Ethernet connectors.
- Depending on the capability of the PC being used, there may be a chance that the effect of High-Speed Download function is only marginal.

4.1.6. Simultaneous Replay/Record Function

With this system, the data recording memory may be divided into two active sections, which allows the user to record an ongoing event into one of the sections while replaying the image recorded in the other section.

Reference

- For information on the operation of the function, please refer to “Photron FASTCAM Viewer Users’ Manual”.

4.1.7. Gigabit Ethernet Interface Initialization

When you cannot communicate well with the camera even though you are running PFV, the system's control software, you may be able to improve the situation by performing the procedure below.

1. Of the four USER SW (programmable switches) on the back of the camera body, press and hold USER1 and USER4 for **10 seconds** or more.
2. The LEDs on the rear of the camera body will illuminate back and forth from left to right and from right to left and inform you that the initialization of the Gigabit Ethernet interface has completed normally.

Caution

- Pressing and holding on the USER SW (Programmable Switch) for more than 15 seconds will result in an IP Address Initialization.

4.1.8. Camera IP Address Initialization

In some circumstance when the IP address is changed, and the new IP address is not explicit, an IP Address Initialization operation is recommended. In this case, the IP address will be reset to 192.168.0.10 as the factory settings.

1. Of the four USER SW (programmable switches) on the back of the camera body, press and hold USER1 and USER4 for **15 seconds** or more.
2. When the LEDs blink from left to right and then from right to left alternately, it indicates the initialization operation is accomplished.

MEMO

Chapter. 5 **Product Specifications**

5.1. Specifications

5.2. Dimentions

5.1. Specifications

5.1.1. Product Specifications

Image Sensor	CMOS image sensor	
Sensor Resolution	1,024 x 1,024 pixels	
Frame Rate	When full frame: 20,000fps max. When a frame segment: 480,000fps max.	
Lens Mount	G type F mount, C mount, EF mount (optional)	
Recording Color Depth	Monochrome	12bit / 8bit
	Color	RGB, each 12bit / 8bit(Bayer color filter method)
Shutter Method	Electronic shutter	
Recording Method	IC memory	
Recording Memory Capacity	8 GB (type 1), 16 GB (type 2), 32 GB (type 3) , 64 GB (type 4)	
Trigger Method	START, CENTER, END, MANUAL, RANDOM RANDOM RESET, RANDOM CENTER, RANDOM MANUAL	
Gain Control	Hardware LUT on camera Controllable via Remote Controller or software	
Image Output Customization	Customizable LUT, brightness is changeable	
External Synchronization Input Signal	+3.3 to +12Vp-p, negative polarity/positive polarity (switchable)	
External Synchronization Output Signal	5 Vp-p, negative polarity/positive polarity (switchable)	
Trigger Input Signal	TTL(+3.3 to +12V), contact	
Other Output Signals	Other timing signal outputs	
External Control	Remote Controller, RS-422 external control I/F, Gigabit Ethernet I/F (PC)	
Video Output Signal	NTSC/PAL, HD SDI (Compliant with SMPTE 292M) -(NTSC mode) 1080i / 60Hz , 59.94Hz 1080p / 30Hz , 29.97Hz , 24Hz , 23.98Hz , 24Hz(sF) , 23.98Hz(sF) -(PAL mode) 1080i / 50Hz 1080p / 25Hz , 24Hz , 23.98Hz , 24Hz(sF) , 23.98Hz(sF) With digital zoom, scroll, fit functions	
Digital Interface	Gigabit Ether x2 Port(1000BASE-T), SD Card Slot	

5.1.2. General Specifications

Environment Conditions	
Storage Temperature	-20℃ - 60℃ (No Condensation) -4ºF - 140ºF (No Condensation)
Storage Humidity	85% or less (No Condensation)
Operating Temperature	0 - 45℃ (No Condensation) 32ºF - 104ºF (No Condensation)
Operating Humidity	85% or less (No Condensation)
Pollution degree	Degree 2 according to IEC60664-1
Overvoltage category	Category II according to IEC60664-1
Maximum use altitude	2,000m or lower
External Dimensions	
Camera Body	261.6 (H) x 150 (W) x 375.4 (D) mm, excluding protrusion 10.3" (H) x 5.9" (W) x 14.8" (D)
AC Adapter	37 (H) x 88.5 (W) x 218 (D) mm, excluding protrusion 1.5” (W) x 3.5” (H) x 8.9” (D)
AC Power Supply	
Supply Voltage	100V - 240V (type A cable: up to 125V)
Supply Frequency	50Hz - 60Hz
Power Consumption	230W
DC Power Supply	
Power Voltage	20V - 36 V
Power Consumption	230VA
Weight	
Camera Body	10.4 kg 22.93 lbs, excluding protrusion
AC Adapter	1.0 kg 35.27 oz.

Photron has verified two types of AC cables, type A (standard for Japan, USA, Canada, etc.) and type SE (standard for Germany, France, etc.). However, when those cables cannot properly receive power when plugged in, use the proper AC cable for the region's standards and verify that AC cable works properly.

For inquires regarding the recommended AC cable for each region, contact that region's Photron branch office or the distributor.

5.1.3. Options

User Option
Remote Controller for SA8/SA-X/SA-X2/SA-Z
Remote Controller with LCD for SA-X2/SA-Z
EF Remote Controll Mount Option for SA-Z
FASTCAM SA-Z Specialized Carrying Case
Photron Trigger Box
Mount with Filter changer(3 type)
Mount with Filter changer(1 type)

MEMO

5.1.4. Frame Rate and Resolution

20K Mode ON(1,024 x 1,024 - 640 x 280)

Resolution / Frame rate (fps)	1,024 × 1,024	1,024 × 1,000	1,024 × 840	1,024 × 688	1,024 × 512	896 × 896	896 × 448	896 × 368	768 × 768	768 × 512	768 x 352	640 × 512	640 × 360	640 × 280
50 (PAL)	○	○	○	○	○	○	○	○	○	○	○	○	○	○
60	○	○	○	○	○	○	○	○	○	○	○	○	○	○
125	○	○	○	○	○	○	○	○	○	○	○	○	○	○
250	○	○	○	○	○	○	○	○	○	○	○	○	○	○
500	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
3,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
5,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
6,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
7,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
8,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
9,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
10,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
20,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
21,000		○	○	○	○	○	○	○	○	○	○	○	○	○
25,000			○	○	○	○	○	○	○	○	○	○	○	○
30,000				○	○		○	○	○	○	○	○	○	○
40,000					○		○	○		○	○	○	○	○
50,400							○	○		○	○	○	○	○
60,000								○			○		○	○
70,000											○		○	○
80,000													○	○
100,000														○
210,000														
300,000														
480,000														

The circle indicates a possible setting. The green items are the maximum resolution setting at that frame rate. This table is the list of default settings. Even finer settings are possible with the variable setting.

(512 x 512 - 128 x 8)

Resolution / Frame rate(fps)	512 × 512	512 × 256	384 × 256	384 × 160	256 × 256	256 × 128	128 × 80	256 × 56	128 × 56	128 × 32	128 × 16	128 × 8
50 (PAL)	○	○	○	○	○	○	○	○	○	○	○	○
60	○	○	○	○	○	○	○	○	○	○	○	○
125	○	○	○	○	○	○	○	○	○	○	○	○
250	○	○	○	○	○	○	○	○	○	○	○	○
500	○	○	○	○	○	○	○	○	○	○	○	○
1,000	○	○	○	○	○	○	○	○	○	○	○	○
2,000	○	○	○	○	○	○	○	○	○	○	○	○
3,000	○	○	○	○	○	○	○	○	○	○	○	○
4,000	○	○	○	○	○	○	○	○	○	○	○	○
5,000	○	○	○	○	○	○	○	○	○	○	○	○
6,000	○	○	○	○	○	○	○	○	○	○	○	○
7,000	○	○	○	○	○	○	○	○	○	○	○	○
8,000	○	○	○	○	○	○	○	○	○	○	○	○
9,000	○	○	○	○	○	○	○	○	○	○	○	○
10,000	○	○	○	○	○	○	○	○	○	○	○	○
20,000	○	○	○	○	○	○	○	○	○	○	○	○
21,000	○	○	○	○	○	○	○	○	○	○	○	○
25,000	○	○	○	○	○	○	○	○	○	○	○	○
30,000	○	○	○	○	○	○	○	○	○	○	○	○
40,000	○	○	○	○	○	○	○	○	○	○	○	○
50,400	○	○	○	○	○	○	○	○	○	○	○	○
60,000	○	○	○	○	○	○	○	○	○	○	○	○
70,000		○	○	○	○	○	○	○	○	○	○	○
80,000		○	○	○	○	○	○	○	○	○	○	○
100,000		○	○	○	○	○	○	○	○	○	○	○
210,000				○		○	○	○	○	○	○	○
300,000						○	○	○	○	○	○	○
480,000							○	○	○	○	○	○

The circle indicates a possible setting.The green items are the maximum resolution setting at that frame rate.
This table is the list of default settings. Even finer settings are possible with the variable setting.

20K Mode OFF(1,024 x 1,024 - 384 x 384)

Resolution / Frame rate (fps)	1,024 × 1,024	1,024 × 984	1,024 × 888	896 × 896	896 × 808	768 × 760	768 × 664	768 × 584	640 × 640	640 × 584	512 × 512	512 × 432	512 × 312	384 × 384
50 (PAL)	○	○	○	○	○	○	○	○	○	○	○	○	○	○
60	○	○	○	○	○	○	○	○	○	○	○	○	○	○
125	○	○	○	○	○	○	○	○	○	○	○	○	○	○
250	○	○	○	○	○	○	○	○	○	○	○	○	○	○
500	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
3,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
5,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
6,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
7,200	○	○	○	○	○	○	○	○	○	○	○	○	○	○
8,000	○	○	○	○	○	○	○	○	○	○	○	○	○	○
9,000		○	○	○	○	○	○	○	○	○	○	○	○	○
10,000			○	○	○	○	○	○	○	○	○	○	○	○
12,000					○	○	○	○	○	○	○	○	○	○
14,000						○	○	○	○	○	○	○	○	○
16,000							○	○	○	○	○	○	○	○
18,000								○	○	○	○	○	○	○
20,000										○	○	○	○	○
30,000												○	○	○
40,000													○	
50,400													○	
60,000														
70,000														
80,000														
90,000														
100,800														
150,000														
200,000														
240,000														

The circle indicates a possible setting.The green items are the maximum resolution setting at that frame rate.
This table is the list of default settings. Even finer settings are possible with the variable setting.

(384 x 280 - 128 x 8)

Resolution / Frame rate (fps)	384 × 280	384 × 224	256 × 256	256 × 224	256 × 184	256 × 160	256 × 136	128 × 128	128 × 88	128 × 48	128 × 24	128 × 8
50 (PAL)	○	○	○	○	○	○	○	○	○	○	○	○
60	○	○	○	○	○	○	○	○	○	○	○	○
125	○	○	○	○	○	○	○	○	○	○	○	○
250	○	○	○	○	○	○	○	○	○	○	○	○
500	○	○	○	○	○	○	○	○	○	○	○	○
1,000	○	○	○	○	○	○	○	○	○	○	○	○
2,000	○	○	○	○	○	○	○	○	○	○	○	○
3,000	○	○	○	○	○	○	○	○	○	○	○	○
4,000	○	○	○	○	○	○	○	○	○	○	○	○
5,000	○	○	○	○	○	○	○	○	○	○	○	○
6,000	○	○	○	○	○	○	○	○	○	○	○	○
7,200	○	○	○	○	○	○	○	○	○	○	○	○
8,000	○	○	○	○	○	○	○	○	○	○	○	○
9,000	○	○	○	○	○	○	○	○	○	○	○	○
10,000	○	○	○	○	○	○	○	○	○	○	○	○
12,000	○	○	○	○	○	○	○	○	○	○	○	○
14,000	○	○	○	○	○	○	○	○	○	○	○	○
16,000	○	○	○	○	○	○	○	○	○	○	○	○
18,000	○	○	○	○	○	○	○	○	○	○	○	○
20,000	○	○	○	○	○	○	○	○	○	○	○	○
30,000	○	○	○	○	○	○	○	○	○	○	○	○
40,000	○	○	○	○	○	○	○	○	○	○	○	○
50,400	○	○	○	○	○	○	○	○	○	○	○	○
60,000		○	○	○	○	○	○	○	○	○	○	○
70,000				○	○	○	○	○	○	○	○	○
80,000					○	○	○	○	○	○	○	○
90,000						○	○	○	○	○	○	○
100,800							○	○	○	○	○	○
150,000									○	○	○	○
200,000										○	○	○
240,000											○	○

The circle indicates a possible setting.The green items are the maximum resolution setting at that frame rate. This table is the list of default settings. Even finer settings are possible with the variable setting.

5.1.5. Shutter Speed List (uncertain interval extension: Disable)

Shutter Speed						
1,000	2,105	3,077	5,714	12,308	22,857	160,000
1,020	2,128	3,125	5,882	12,500	23,529	200,000
1,042	2,151	3,175	6,061	12,698	24,242	266,667
1,064	2,174	3,226	6,250	12,903	25,000	400,000
1,087	2,198	3,279	6,452	13,115	25,806	800,000
1,111	2,222	3,333	6,667	13,333	26,667	998,020
1,136	2,247	3,390	6,897	13,559	27,586	
1,163	2,273	3,448	7,143	13,793	28,571	
1,190	2,299	3,509	7,407	14,035	29,630	
1,220	2,326	3,571	7,692	14,286	30,769	
1,250	2,353	3,636	8,000	14,545	32,000	
1,282	2,381	3,704	8,333	14,815	33,333	
1,316	2,410	3,774	8,696	15,094	34,783	
1,351	2,439	3,846	9,091	15,385	36,364	
1,389	2,469	3,922	9,524	15,686	38,095	
1,429	2,500	4,000	10,000	16,000	40,000	
1,471	2,532	4,082	10,127	16,327	42,105	
1,515	2,564	4,167	10,256	16,667	44,444	
1,563	2,597	4,255	10,390	17,021	47,059	
1,613	2,632	4,348	10,526	17,391	50,000	
1,667	2,667	4,444	10,667	17,778	53,333	
1,724	2,703	4,545	10,811	18,182	57,143	
1,786	2,740	4,651	10,959	18,605	61,538	
1,852	2,778	4,762	11,111	19,048	66,667	
1,923	2,817	4,878	11,268	19,512	72,727	
2,000	2,857	5,000	11,429	20,000	80,000	
2,020	2,899	5,128	11,594	20,513	88,889	
2,041	2,941	5,263	11,765	21,053	100,000	
2,062	2,985	5,405	11,940	21,622	114,286	
2,083	3,030	5,556	12,121	22,222	133,333	

The unit in the chart is 1/x s

5.1.6. Shutter Speed List (uncertain interval extension: Enable)

Shutter Speed						
999	2,102	3,070	5,692	12,203	22,500	144,000
1,020	2,125	3,118	5,858	12,392	23,151	175,610
1,041	2,147	3,168	6,035	12,587	23,841	225,000
1,063	2,171	3,219	6,223	12,789	24,573	313,043
1,086	2,194	3,271	6,423	12,996	25,352	514,286
1,110	2,219	3,326	6,636	13,211	26,182	589,474
1,135	2,244	3,382	6,864	13,433	27,068	
1,162	2,269	3,440	7,108	13,662	28,016	
1,189	2,295	3,500	7,369	13,900	29,032	
1,218	2,322	3,563	7,651	14,145	30,126	
1,249	2,349	3,627	7,956	14,400	31,304	
1,281	2,377	3,694	8,285	14,664	32,579	
1,315	2,406	3,764	8,643	14,938	33,962	
1,350	2,435	3,836	9,034	15,222	35,468	
1,388	2,465	3,911	9,461	15,517	37,113	
1,427	2,496	3,989	9,931	15,824	38,919	
1,469	2,527	4,070	10,056	16,143	40,909	
1,514	2,560	4,155	10,184	16,476	43,114	
1,561	2,593	4,243	10,315	16,822	45,570	
1,611	2,627	4,335	10,450	17,184	48,322	
1,665	2,662	4,431	10,588	17,561	51,429	
1,722	2,698	4,531	10,730	17,955	54,962	
1,784	2,735	4,636	10,876	18,367	59,016	
1,849	2,772	4,746	11,026	18,799	63,717	
1,921	2,811	4,862	11,180	19,251	69,231	
1,997	2,851	4,983	11,339	19,726	75,789	
2,017	2,893	5,110	11,502	20,225	83,721	
2,038	2,935	5,244	11,669	20,749	93,506	
2,059	2,979	5,385	11,842	21,302	105,882	
2,080	3,024	5,534	12,020	21,884	122,034	

The unit in the chart is 1/x s

5.1.7. Shutter Speed List (special mode)

Resolution (Horizon)	Resolution (Vertical)			
	64	56	48	40
1,024	over 224,001 fps	over 240,001 fps	over 262,501 fps	over 300,001 fps
896	over 240,001 fps	over 262,501 fps	over 288,001 fps	over 315,001 fps
768	over 262,501 fps	over 288,001 fps	over 315,001 fps	over 350,001 fps
640	over 300,001 fps	over 315,001 fps	over 350,001 fps	over 360,001 fps
512	over 336,001 fps	over 360,001 fps	over 360,001 fps	over 400,001 fps
384	over 360,001 fps	over 400,001 fps	over 400,001 fps	-
256	over 400,001 fps	over 450,001 fps	-	-
128	-	-	-	-

Resolution (Horizon)	Resolution (Vertical)			
	32	24	16	8
1,024	over 336,001 fps	over 360,001 fps	over 450,001 fps	-
896	over 360,001 fps	over 400,001 fps	-	-
768	over 360,001 fps	over 450,001 fps	-	-
640	over 400,001 fps	-	-	-
512	over 450,001 fps	-	-	-
384	-	-	-	-
256	-	-	-	-
128	-	-	-	-

In case of setup frame rate, each resolution in table can use below shutter speed.

(the ‘uncertain interval extension’ is disabled)

Shutter Speed
998,020

The unit in the chart is 1/x s

(the ‘uncertain interval extension’ is enabled)

Shutter Speed
370,588
690,411
833,058

The unit in the chart is 1/x s

MEMO

5.1.8. Shutter Speed List (20K mode OFF / uncertain interval extension: Disable)

Shutter Speed						
1,000	2,105	3,077	5,714	12,308	22,857	160,000
1,020	2,128	3,125	5,882	12,500	23,529	200,000
1,042	2,151	3,175	6,061	12,698	24,242	266,667
1,064	2,174	3,226	6,250	12,903	25,000	400,000
1,087	2,198	3,279	6,452	13,115	25,806	800,000
1,111	2,222	3,333	6,667	13,333	26,667	998,020
1,136	2,247	3,390	6,897	13,559	27,586	
1,163	2,273	3,448	7,143	13,793	28,571	
1,190	2,299	3,509	7,407	14,035	29,630	
1,220	2,326	3,571	7,692	14,286	30,769	
1,250	2,353	3,636	8,000	14,545	32,000	
1,282	2,381	3,704	8,333	14,815	33,333	
1,316	2,410	3,774	8,696	15,094	34,783	
1,351	2,439	3,846	9,091	15,385	36,364	
1,389	2,469	3,922	9,524	15,686	38,095	
1,429	2,500	4,000	10,000	16,000	40,000	
1,471	2,532	4,082	10,127	16,327	42,105	
1,515	2,564	4,167	10,256	16,667	44,444	
1,563	2,597	4,255	10,390	17,021	47,059	
1,613	2,632	4,348	10,526	17,391	50,000	
1,667	2,667	4,444	10,667	17,778	53,333	
1,724	2,703	4,545	10,811	18,182	57,143	
1,786	2,740	4,651	10,959	18,605	61,538	
1,852	2,778	4,762	11,111	19,048	66,667	
1,923	2,817	4,878	11,268	19,512	72,727	
2,000	2,857	5,000	11,429	20,000	80,000	
2,020	2,899	5,128	11,594	20,513	88,889	
2,041	2,941	5,263	11,765	21,053	100,000	
2,062	2,985	5,405	11,940	21,622	114,286	
2,083	3,030	5,556	12,121	22,222	133,333	

The unit in the chart is 1/x s

5.1.1. Shutter Speed List (20K mode OFF / uncertain interval extension: Enable)

Shutter Speed						
999	2,100	3,066	5,678	12,142	22,291	135,849
1,019	2,123	3,114	5,844	12,329	22,930	163,636
1,040	2,145	3,163	6,020	12,522	23,607	205,714
1,063	2,169	3,214	6,207	12,721	24,324	276,923
1,086	2,192	3,267	6,406	12,926	25,087	423,529
1,110	2,217	3,321	6,618	13,139	25,899	473,239
1,135	2,242	3,377	6,844	13,358	26,766	
1,161	2,267	3,435	7,087	13,585	27,692	
1,189	2,293	3,495	7,347	13,820	28,685	
1,218	2,320	3,557	7,627	14,063	29,752	
1,248	2,347	3,622	7,930	14,314	30,901	
1,280	2,375	3,689	8,257	14,575	32,143	
1,314	2,403	3,758	8,612	14,845	33,488	
1,349	2,432	3,830	9,000	15,126	34,951	
1,387	2,462	3,905	9,424	15,418	36,548	
1,426	2,493	3,982	9,890	15,721	38,298	
1,468	2,525	4,063	10,014	16,036	40,223	
1,513	2,557	4,147	10,141	16,364	42,353	
1,560	2,590	4,235	10,271	16,705	44,720	
1,610	2,624	4,327	10,405	17,062	47,368	
1,664	2,659	4,423	10,542	17,433	50,350	
1,721	2,695	4,523	10,682	17,822	53,731	
1,782	2,731	4,627	10,827	18,228	57,600	
1,848	2,769	4,737	10,976	18,653	62,069	
1,919	2,808	4,852	11,128	19,098	67,290	
1,996	2,848	4,972	11,285	19,565	73,469	
2,016	2,889	5,099	11,447	20,056	80,899	
2,036	2,932	5,233	11,613	20,571	90,000	
2,057	2,975	5,373	11,784	21,114	101,408	
2,079	3,020	5,521	11,960	21,687	116,129	

The unit in the chart is 1/x s

5.1.2. Recordable Image Count/Resolution (12bit)

Resolution	8G Model Rec. Frames	16G Model Rec. Frames	32G Model Rec. Frames	64G Model Rec. Frames
1,024×1,024	5,455	10,916	21,839	43,684
1,024×1,000	5,586	11,178	22,363	44,733
1,024×840	6,650	13,308	26,623	53,254
1,024×688	8,120	16,249	32,506	65,020
1,024×512	10,912	21,835	43,680	87,371
896×448	14,253	28,520	57,052	114,118
896×368	17,352	34,720	69,456	138,927
768×352	21,165	42,349	84,715	169,449
640×360	24,834	49,690	99,400	198,820
640×280	31,931	63,887	127,801	255,627
384×160	93,136	186,343	372,756	745,583
256×128	174,632	349,395	698,920	1,397,971
128×80	558,828	1,118,069	2,236,550	4,473,512
256×56	399,162	798,620	1,597,535	3,195,365
128×56	798,327	1,597,242	3,195,073	6,390,733
128×32	1,397,075	2,795,176	5,591,379	11,183,784
128×16	2,794,152	5,590,355	11,182,760	22,367,571
128×8	5,588,307	11,180,712	22,365,523	44,735,144

* Recording Time = Rec. Frames x 1/frame rate (fps)

5.1.3. Recordable Image Count/Resolution (8bit)

Resolution	8G Model Rec. Frames	16G Model Rec. Frames	32G Model Rec. Frames	64G Model Rec. Frames
1,024×1,024	8,186	16,378	32,762	65,530
1,024×1,000	8,382	16,771	33,548	67,102
1,024×840	9,979	19,966	39,938	79,884
1,024×688	12,184	24,377	48,763	97,534
1,024×512	16,374	32,758	65,526	131,062
896×448	21,387	42,786	85,585	171,183
896×368	26,036	52,088	104,191	208,397
768×352	31,757	63,532	127,082	254,182
640×360	37,262	74,545	149,110	298,241
640×280	47,909	95,844	191,714	383,453
384×160	139,739	279,550	559,170	1,118,410
256×128	262,014	524,158	1,048,446	2,097,022
128×80	838,449	1,677,310	3,355,031	6,710,474
256×56	598,891	1,198,078	2,396,450	4,793,195
128×56	1,197,785	2,396,158	4,792,903	9,586,393
128×32	2,096,126	4,193,278	8,387,582	16,776,190
128×16	4,192,254	8,386,558	16,775,166	33,552,382
128×8	8,384,510	16,773,118	33,550,334	67,104,766

* Recording Time = Rec. Frames x 1/frame rate (fps)

5.1.4. Recordable Times/Resolution (12bit)

Resolution	Max Framerate	8G Model Rec Times	16G Model Rec Times	32G Model Rec Times	64G Model Rec Times
1,024×1,024	20,000	0.273	0.546	1.092	2.184
1,024×1,000	21,000	0.266	0.532	1.065	2.130
1,024×840	25,000	0.266	0.532	1.065	2.130
1,024×688	30,000	0.271	0.542	1.084	2.167
1,024×512	40,000	0.273	0.546	1.092	2.184
896×448	50,400	0.283	0.566	1.132	2.264
896×368	60,000	0.289	0.579	1.158	2.315
768×352	70,000	0.302	0.605	1.210	2.421
640×360	80,000	0.310	0.621	1.243	2.485
640×280	100,000	0.319	0.639	1.278	2.556
384×160	210,000	0.444	0.887	1.775	3.550
256×128	300,000	0.582	1.165	2.330	4.660
128×80	480,000	1.164	2.329	4.659	9.320

The unit in the chart is sec

5.1.5. Recordable Times/Resolution (8bit)

Resolution	Max Framerate	8G Model Rec Times	16G Model Rec Times	32G Model Rec Times	64G Model Rec Times
1,024×1,024	20,000	0.409	0.819	1.638	3.277
1,024×1,000	21,000	0.399	0.799	1.598	3.195
1,024×840	25,000	0.399	0.799	1.598	3.195
1,024×688	30,000	0.406	0.813	1.625	3.251
1,024×512	40,000	0.409	0.819	1.638	3.277
896×448	50,400	0.424	0.849	1.698	3.396
896×368	60,000	0.434	0.868	1.737	3.473
768×352	70,000	0.454	0.908	1.815	3.631
640×360	80,000	0.466	0.932	1.864	3.728
640×280	100,000	0.479	0.958	1.917	3.835
384×160	210,000	0.665	1.331	2.663	5.326
256×128	300,000	0.873	1.747	3.495	6.990
128×80	480,000	1.747	3.494	6.990	13.980

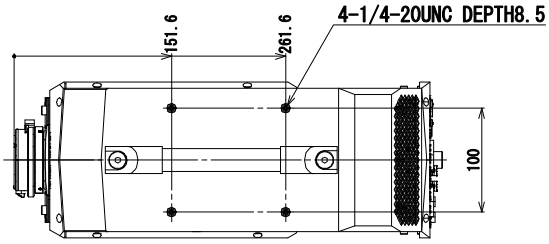
The unit in the chart is sec

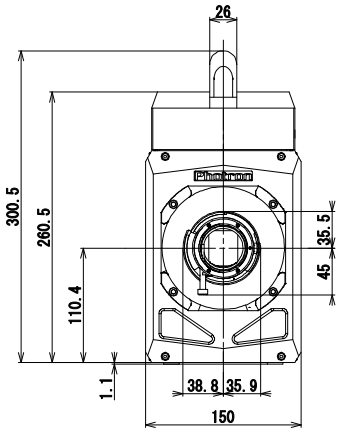
5.2. Dimensions

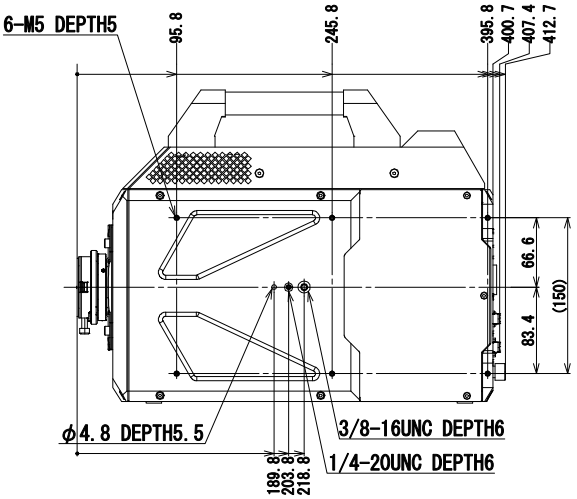
5.2.1. Camera Body

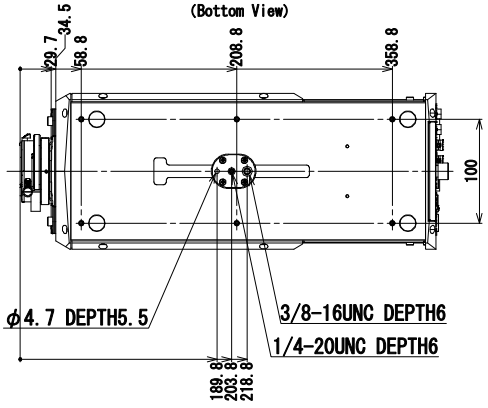
FASTCAM SA-Z G type F mount

(mm)



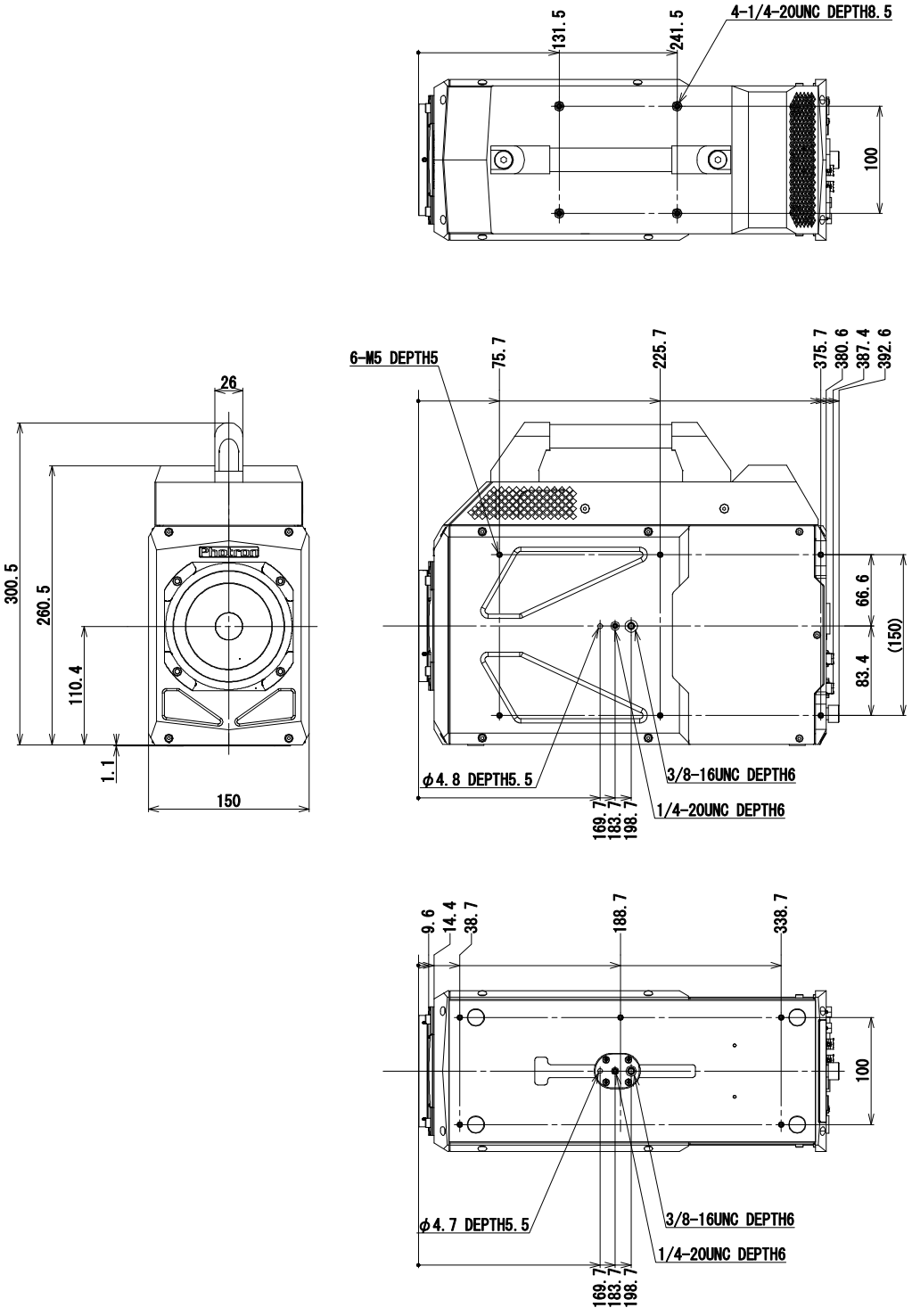






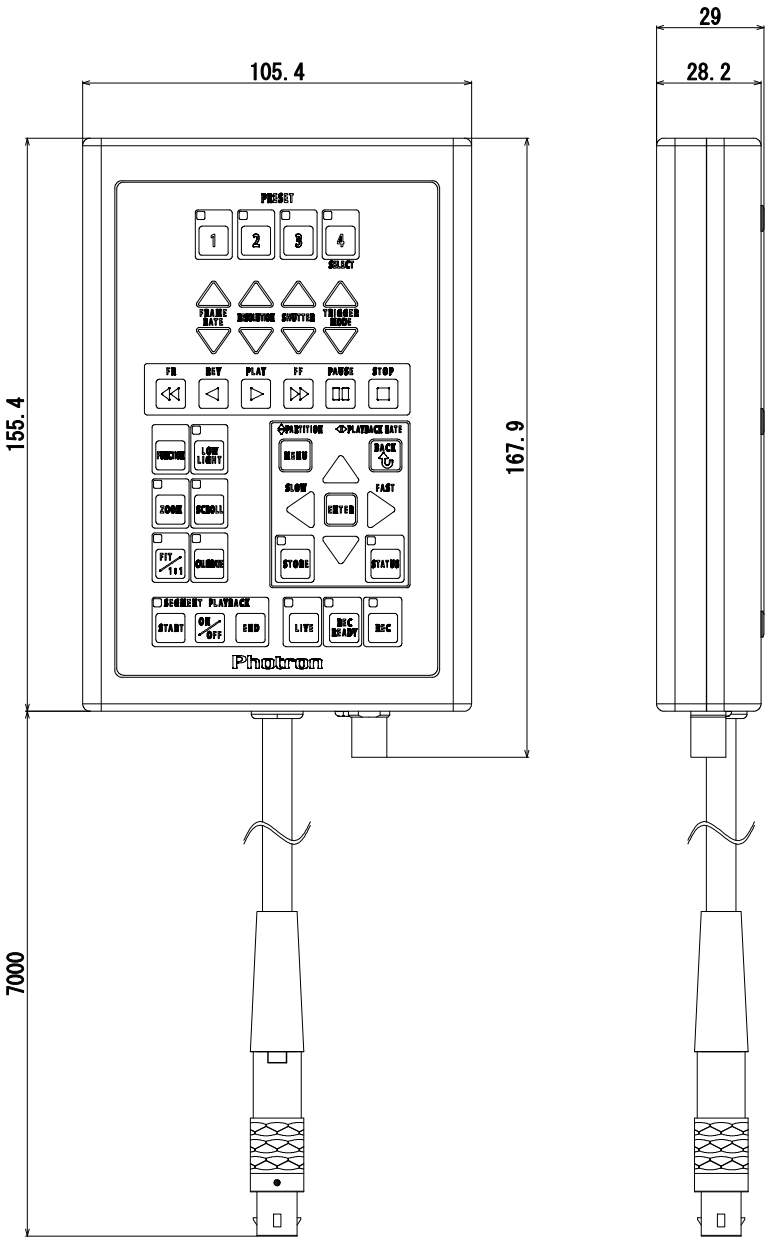
FASTCAM SA-Z C mount

(mm)



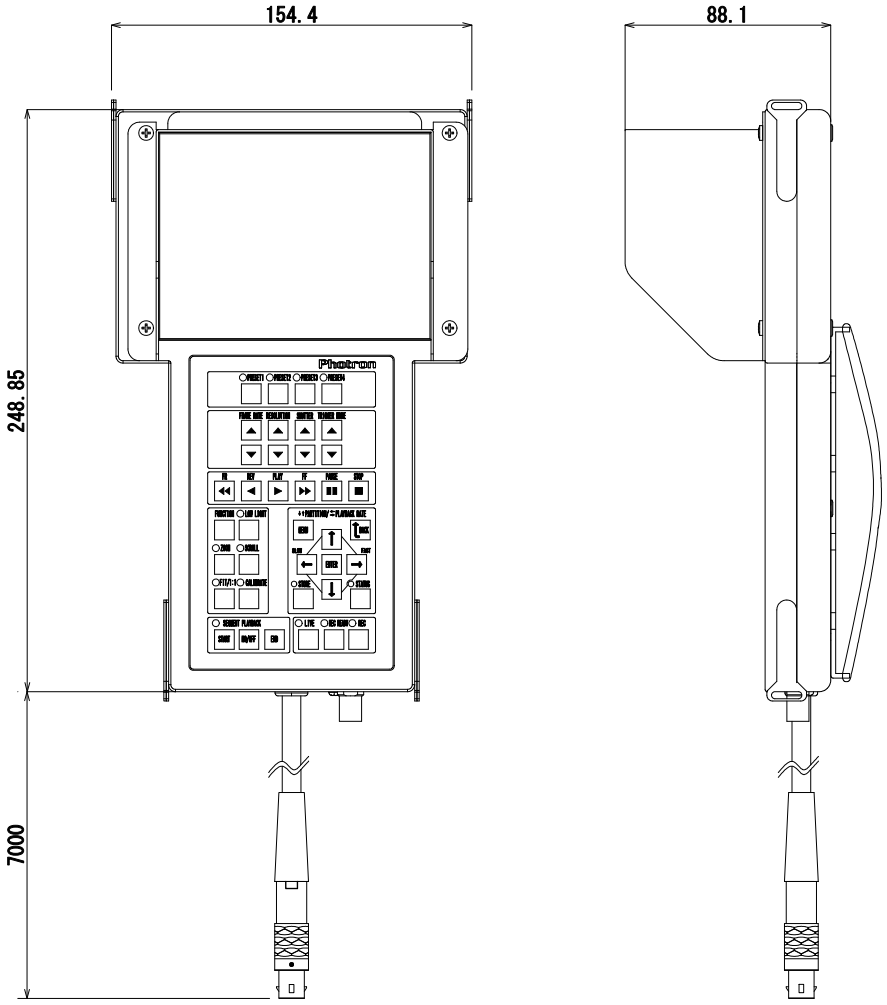
5.2.2. Remote Controller (Optional)

(mm)



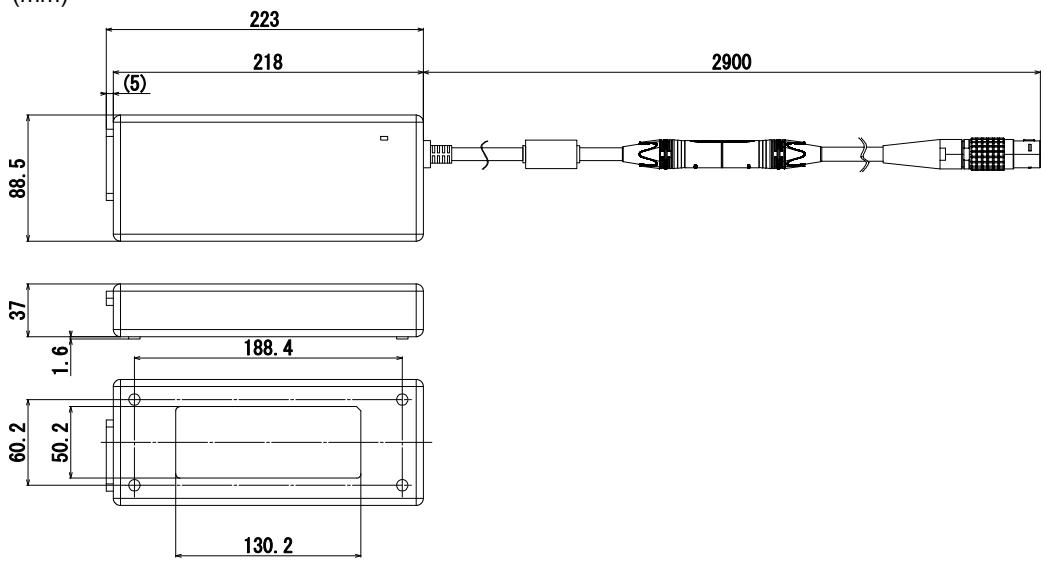
5.2.3. Remote Controller with LCD (Optional)

(mm)



5.2.4. AC Power Supply Unit

(mm)



Chapter. 6 **Warranty**

6.1. About the Warranty

6.1. About the Warranty

This system has been shipped having undergone rigorous testing. However, in the unlikely event that it malfunctions due to a manufacturing defect, it will be repaired, at no charge, within the warranty period.

- Warranty Exceptions
  The following exceptions will result in fee-based repair, even within the warranty period.

  1. Damage or malfunction as a result of fire, earthquake, water damage, lightning, other natural disasters, pollution, or the effects of abnormal voltage.
  2. Damage or malfunction as a result of dropping or mishandling during shipment or when moving after purchase or misuse.
  3. Consumable goods (cables)
  4. When repair, adjustment, or alternation done by an entity other than Photron service has been performed on the system, or damage or malfunction that is determined to be attributed to a fault in the use the product.

For inquires related to malfunction, contact the dealer where the product was purchased, or the nearest Photron office.

Reference

- For inquires related to our product, refer to "7.1. Contact Information", page 98.

Chapter. 7 Contacting Photron

7.1. Contact Information

7.1. Contact Information

For inquires related to PFV, contact Photron at the contact information listed below.
Additionally, the following items will be verified when inquiring, so please prepare them in advance.

Items Verified	Concrete Example
Contact Information	Company, school or organization name, customer contact name, contact phone number, contact e-mail address.
Product Name	FASTCAM SA-Z
Serial Number	Check on the nameplate seal.
Condition of the system and what is known about it.	

Contact Information	
In Americas and Antipodes	**PHOTRON USA, INC.** 9520 Padgett Street, Suite 110 San Diego, CA 92126-4426, USA Phone : 800-585-2129 or 858-684-3555 Fax : 858-684-3558 E-mail : image@photron.com www.photron.com
In Europe, Africa and India	**PHOTRON EUROPE LIMITED** The Barn, Bottom Road, West Wycombe, Buckinghamshire, HP14 4BS, U.K. Phone : +44(0) 1494 48 1011 Fax : +44(0) 1494 48 7011 E-mail : image@photron.com www.photron.com
In other areas	**PHOTRON LIMITED** Fujimi 1-1-8, Chiyoda-Ku Tokyo 102-0071, Japan Phone : +81 3 3238 2107 Fax : +81 3 3238 2109 E-mail : image@photron.co.jp www.photron.co.jp

FASTCAM SA-Z

Hardware Manual Revision 1.00 USEU

Publication Date December, 2013
Publisher PHOTRON LIMITED
Chiyoda Fujimi Bldg., Fujimi 1-1-8, Chiyoda-ku, Tokyo 102-0071

©2013.PHOTRON LIMITED, All rights reserved. Printed in Japan.
(Control No. J131201U)